POWER

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Keep in Line

UPON the friendly road of peaceful and orderly progress there are two disturbers who particularly ruffle my equanimity.

One is the fellow who will not keep his place in the line but goes dashing ahead, crowding others to the gutter, making them clear places for his spurts, and compelling the whole procession to contribute to his progress.

The other is the smug, complacent individual who settles down in the middle of the road to a rate of progress that he considers seemly and proper, and resents and expostulates against any attempt upon anybody's part to get ahead of him.

If it were not for this second sort there would be less occasion and justification for some of the excesses of the first.

You know the type. You meet him in business and social life as well as upon the asphalt and concrete. His rate of progress is set by his own limitations of ambition and ability; but let him sense anybody coming up to pass him.

Does he pull off to one side and give the fellow traveler who is equipped for and desirous of going faster a chance? Instead, he seems to rate his own progress by its relation to that of others rather than to the destination sought. He crabs the road and steps on the gas in remonstrance to being passed, is satisfied at keeping up with the procession while his obstructive tactics succeed, and curses the presumption of his competitor when sufficient breadth of opportunity permits him to get by.

Not all do this. The roads would be impossible without the driver who pleasantly lets you pass. Life would be less easy if everybody thought he could get ahead by holding the other back. It is the type that does, the ones who are unhappy over the progress of others, that exasperates me.

All the same, the fellow who will not stay in line is a nuisance and a menace.

I do not mean the fellow who wants the room and the right, without menace to others or violence to safety and order, to get ahead as fast as his equipment, his ability to handle it, and his knowledge of where he is going and how to get there, warrant. But the man who takes reckless and unwarranted chances, who gets into jams and squeezes out only by imposition upon or by the complaisance of others, who makes a great record only by arrogating opportunity and then crows over it, who crowds people into the ditch, who goes down to destruction dragging others with him—you will find in business and society as well as on the road. And traffic regulations bother him as little in one case as in the other.

F. R. Low

EDITORIALS

The Economic Rating of a Boiler

THE LIMITS of thermal efficiency in power-plant design are now fairly well known, and the gains from decreased coal consumption in new stations will be small. Attention is now being directed to the possibilities of lowering power costs through decreased plant investment. The boiler plant is an expensive element in total plant cost, and thought should therefore be directed to the possibilities of decreasing this item. In this connection the question arises, "What is the economic rating of a boiler?"

A few years ago some engineers had rather definite ideas on this question. The problem has changed of late, and the answer is less apparent. In fact, it is now a complicated and involved process to calculate the economic rating of a given amount of boiler surface.

In the first place, the capacities of stokers and of pulverized coal furnaces have been greatly increased. The type of water wall used and its heat-absorbing capacity adds another factor to the problem. Varying areas of water walls are required by differing operating conditions.

One must also consider the possibilities of modern steel-tube economizers where better heat transfer may be secured than in the same area of rear tube boiler surface, since temperature differences are greater. The economic size of this economizer must be determined as well as that of the boiler. Similar problems arise in fixing the heating surface of air preheaters. The use of either economizer or air preheater, or both, tends to flatten the over-all efficiency curve so that remarkably high efficiencies may be secured at very high boiler ratings.

Auxiliary power requirements must be given consideration, for at high ratings the energy consumption of forced- and induced-draft fans may become a significant figure.

Finally, the use factor of the boiler, the character of its load, and the cost and character of fuel burned, are important in fixing boiler rating.

The economic rating of a given amount of boiler surface may vary widely with all these different factors. It will be apparent that its determination is no longer a matter of opinion only but must be the result of careful calculations based on the influences noted.

Coal and Ash Handling Warrant More Attention

IN THE early days of mechanical coal handling in the power plant the equipment was simple and crude. Although coal was carried to the boilers more cheaply and in greater quantity than by hand labor, the efficiency and the suitability for specific conditions were given little thought. First cost was allowed to overshadow other considerations.

It did not seem to penetrate that a few cents saved on a ton by an efficient and well-maintained coal- and ash-handling system might make a vast difference in operating expense by the end of the year.

In the course of progress from the small hand-fired boiler to the large units of today, engineering thought eventually turned to coal handling. The mere tonnage required for a single boiler forced the issue. Then came a wave of improvement. Designs were perfected to give greater reliability, longer life, lower maintenance, and lower power requirements per ton handled. Also, fields of profitable application for the various types of equipment are becoming more definitely established, so that coal and ash handling in the power plant is now on a plane commensurate with its importance.

The one thing lacking in many plants is a definite system of periodic inspection involving accurate records of operation and maintenance of coal- and ash-handling equipment. This deficiency may be laid at the door of power plant management. While many plants do employ such systems, the practice should be more general.

What Will You Do, Mr. Air Engineer?

SCIENTIFIC RESEARCH in aëronautics and aërodynamics has uncovered many of the phenomena of air flow without the knowledge of which the present development of the airplane would have been impossible. But the benefits of the new knowledge extend much further than this.

As an instance, wise thinkers in the hydraulic engineering profession have recognized the analogy in the flow of air and water. They have followed carefully the progress of aërodynamics and have gained much thereby.

Just why so many engineers, architects, and manufacturers who specialize in the handling of air do not seem to appreciate the benefits that will accrue from the adaptation of this same knowledge to their business is hard to understand.

There are those who will take exception to this indictment. Nevertheless, to realize its general truth, one need only inspect almost any air-duct system, and many fan and blower installations, to see how little attention has been given to the natural laws of air flow.

It almost seems that, after all other equipment has been advantageously placed, the remaining area is given to the blowers, fans, and ducts, with the feeling that the requisite twists and turns for connections are of no importance.

Entrance losses from improperly formed inlets, discharge losses from lack of attention to transitions, turbulence and eddy losses resulting from angular turns, and unscientific changes of form and direction can all be reduced with proper forethought.

One of these days someone will devote to it the attention the problem deserves, and reduced operating cost will pay the bill.

Misfit Equipment

A MACHINE may be installed in a few days, but it is operated for years. For this reason factors affecting operation should be carefully considered. Mistakes in selecting and installing equipment must be lived with, and they generally are costly. If they are corrected it is usually at considerable expense. A motor and controller suited to their application do not cost any more than ones that are not. Motors too large for their drives are often selected when through the exercise of proper engineering the correct size could have been had at less cost. Overmotoring on alternating-current circuits may prove doubly expensive, because of low efficiency and low power factor.

Motors and controllers not suited to their application are not the only misfits. Frequently, new plants are installed that have several makes of motors and controls, when one would serve the purpose much better. Even if the several makes were obtained at bargain prices they would likely prove expensive. A standard line of equipment can generally be installed more cheaply and a better installation had than where several makes are employed. Besides, they provide a better-looking job. One standard line of motors offers an opportunity for interchange in emergencies, and the spare-part problem is simplified.

One price is paid for equipment and its installation and another for its operation. The former can be determined when the machines are purchased. The latter is an unknown quantity and may be large or small, depending upon the sound judgment put into the selection and installation of the equipment.

Coal or Oil?

IN THE eyes of the public the engineer is a cold-blooded "thinking machine" who always approaches a problem by assembling the facts. Then, according to this conception, he studies his facts and bases his actions on logic alone. Such is the common conception, and also the ideal of engineers themselves.

But in practice the engineer often reveals very human faults that lead away from this ideal. He has his whims, prejudices and misconceptions, and sometimes allows them to get the upper hand.

A good example is found in the choice that must frequently be made between oil and coal as a fuel for boiler furnaces. Admittedly, oil is cleaner and easier for the operating man. That sometimes gives him a bias where oil is not a truly economical fuel.

On the other hand, the conscientious engineer may too easily jump to the conclusion that coal should always be burned where it is cheaper on a B.t.u. basis. The engineering solution is less simple than this. It must involve all elements of fixed and operating charges.

A simple and logical approach to this problem is outlined by Stuart W. Allen in this number. Mr. Allen's analysis will be of particular value to engineers, because he is thoroughly familiar with the ins-and-outs of both coal and oil as boiler fuels, and because, in addition, he knows the practice and language of cost accounting. His article shows how to summarize the study in a way that will make an instant appeal to the management which thinks only in terms of dollars.

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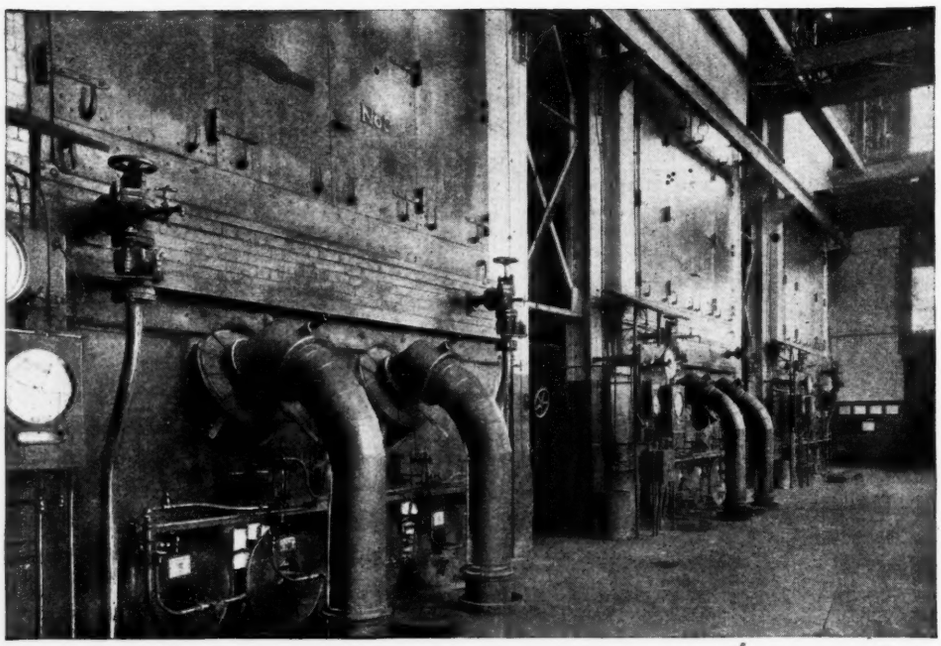
POWER *Stands for . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

Shall It Be

COAL or OIL?



Industrial boiler plant equipped to burn either pulverized coal or oil to take advantage of price fluctuations

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An experienced cost accountant and power engineer shows how to answer this question on a straight dollar basis for any given condition

By STUART W. ALLEN

COAL OR OIL for industrial plant fuel? That is the question in many districts. Reams have been written about the relative advantages of these fuels, but a great many industrials still follow the lead of the central station regardless of the fact that conditions generally are widely different.

When, for example, the engineer of an industrial plant asks for an appropriation to provide for a change of fuel, the answer too often is "If there were anything in it, Bill Jones would shift; he burns ten times the fuel that we do." That "ten times" is the stumbling block, and I shall attempt to show a few of the variables and how they affect the final result.

The first thing to bear in mind in this or any power plant problem is that the total cost over a period of time is the only item of interest to the management; therefore in making up a comparison of the relative merits of coal and oil all items should be reduced to a dollars-and-cents basis.

For instance, ease of operation and cleanliness are items of vast importance to the operating chief, but are of interest to the management principally as they are reflected in the accounting department's books. In this article no attempt will be made to enter into a discussion of such items, but rather the text will be limited to a discussion of direct operating costs, fixed charges, etc.

Items of cost are divided into two general classifications: "Direct cost," covering all items directly chargeable to the operation and for the most part varying in accordance with production, and "fixed charges," covering those items not so directly chargeable. The latter include interest on investment, depreciation, taxes, insurance and any other such item which is fixed in amount.

In making a comparison of costs it has been found of advantage to set down each of these items singly in the group to which it belongs. An example is given in Table I, and will be referred to in more detail later.

If the comparison is to be made for the purpose of deciding on the fuel to be burned in a plant to be built, the capacity of the plant is first determined, and estimated costs are prepared covering coal-burning and oil-burning installations. It will generally be found that the cost of building a coal-burning plant will exceed that of an oil-burning installation.

From the figures thus obtained yearly fixed charges are estimated. These charges will be constant, regardless of production; therefore the unit cost per thousand

pounds of steam for fixed charges will be less at the higher rates of production than at the lower. Consequently, it is of importance that the plant be designed to operate as near to its full capacity as is practicable.

If the boiler house is already in operation and a change from one fuel to the other is contemplated, then the fixed charges under existing conditions must be ascertained and the additional cost necessitated by the change must be estimated. This will raise the annual fixed charges applicable against that particular fuel.

In some cases plants are already equipped to burn both coal and oil or it is desired to construct one so equipped. Then, of course, the fixed charges will be the same for both methods of operation, but may represent different percentages of the total cost.

As fixed charges represent a considerable portion of the cost of generating steam in the average plant, it will be seen from the foregoing that while one plant designed to burn either fuel may find it to advantage to shift because of a temporary drop in price, another plant in which extensive changes are necessary will find it uneconomical to do so. This is true despite the fact that operating conditions in the two plants are similar.

Before the direct charges can be computed, the net steam demand must be estimated. This will not represent the total evaporation by the boilers, but will include only that steam which is transmitted from the boiler house. To produce this amount of steam, certain quantities are used in the boiler house itself, the quantity varying according to the design and type of equipment.

In the comparison given here (Table I) it is assumed that the feed water is heated in both cases to approximately 212 deg. F. and that it is pumped by steam-driven pumps. A certain portion of this water is blown down from the boilers and is never evaporated. Some is used in soot blowers for cleaning the surfaces of boiler tubes.

For comparison, steam-atomizing oil burners have been assumed and the steam estimated for heating and pumping this oil. The coal-burning apparatus has been figured as electrically driven, the item for electric current being higher, consequently, in the coal burning column than in the oil.

In Table I these figures have been compiled on the basis of a steam demand of 480,000,000 lb. per year, representing an average of 40,000,000 lb. per month. Certain assumptions have been made regarding the price of coal and fuel oil, and it has also been necessary to estimate the steam used in the boiler house, amount of fixed charges, etc.

Starting with the assumption of 480,000,000 lb. of steam per year, it was estimated that 40,400,000 lb. in the case of a coal-burning plant, and 61,000,000 lb. in the

TABLE I—COST OF PRODUCING STEAM
(Comparison of coal and oil, twelve-month period)

		Coal	Total	Oil	Total
1	Direct Labor	12 000.00		7 000.00	
2	Salaried Labor	5 000.00		5 000.00	
3	Fuel	116 500.00		131 500.00	
4	Miscellaneous Supplies	600.00		600.00	
5	Repairs	11 200.00		2 815.00	
6	Water	3 120.00		3 240.00	
7	Coal Storage & Reclaiming	7 000.00			
8	Electric Current	7 144.00		580.00	
9	Total Direct Charges		162 564.00		150 735.00
10	Fixed Charges on Buildings	10 500.00		9 000.00	
11	Fixed Charges on Equipment	34 000.00		28 500.00	
12	Fixed Charges on Fuel Inventory	150.00		86.00	
13	Fixed Charges on Outside Coal Handling	1 600.00			
14	Total Fixed Charges		46 250.00		37 586.00
15	Total Expense		208 814.00		188 321.00
	Total Water to Boilers-lbs.-	520,400,000		541,000,000	
	Boiler House Uses (blowdown, atomizing oil, heating and pumping feed water soot-blowers)	40,400,000		61,000,000	
	Net Steam Produced	480,000,000		480,000,000	
	Cost per M Pounds - Net Steam- Total	.433		.392	
	Cost per M Pounds - Net Steam- Direct	.338		.314	

TABLE II—ESTIMATED SAVINGS BY USE OF COAL OR OIL
(Figures based on total costs, including fixed charges)

Coal Price	$1.10 Oil			$1.20 Oil			$1.30 Oil			$1.40 Oil		
	* 30	40	50	30	40	50	30	40	50	30	40	50
$4.00	2 400	2 000	6 500	5 100	12 000	18 500	12 300	21 600	31 000	19 800	31 600	43 500
4.25	6 000	2 800	0	1 500	6 800	12 500	8 700	16 800	24 500	16 200	26 800	37 000
4.50	9 300	7 600	6 000	1 800	2 400	6 500	5 100	12 000	18 500	12 900	22 000	31 000
4.75	13 200	12 400	12 000	5 700	2 400	500	1 200	7 200	12 500	8 700	17 200	25 000
5.00	17 400	17 600	18 500	9 900	7 600	6 000	2 700	2 000	6 000	4 800	12 000	18 500
5.25	20 700	22 400	24 500	13 200	12 400	12 000	6 000	2 800	0	1 500	7 200	12 500
5.50	24 300	27 200	30 500	16 800	17 200	18 000	9 900	7 600	6 000	2 400	2 400	6 500

*Monthly steam production, millions of pounds.
Figures above heavy line indicate saving by use of coal.
Figures below heavy line indicate saving by use of oil.

case of an oil-burning plant would be used in the boiler house. These figures include blowdown, steam for soot blowers, for heating feed water, for pumping feed water, and, in the case of the oil-burning plant, for heating, pumping and atomizing the fuel oil.

It will be noted that the direct labor item is considerably lower for oil than for coal. This is due to the fact that no ashmen are required and no labor is necessary to operate coal crushers, conveyors, etc.

Salaried labor and miscellaneous supplies were estimated as being the same for each plant. These figures may vary slightly, but for all practical purposes can be considered as the same.

The items of fuel are based on assumed prices and will, of course, vary according to plant location. It was also assumed that a slightly better over-all efficiency could be obtained with oil than with coal.

Repairs will also vary with the individual plant, the figures given here being rough estimates only and not intended to give the writer's opinion as to repair costs under general conditions.

The cost of water will vary with local conditions, the amount chargeable against oil being slightly higher than that charged to coal, because the oil-burning equipment uses more steam than does the coal-burning.

The item of coal storage and reclaiming is self-explanatory and will also vary according to local conditions, as will the charge for electric current. The oil-burning boilers in this case are charged only with the current necessary for boiler house lighting, while the current charged against coal burning covers all mechanical drives.

If steam drives are used, this electric charge will be reduced, but the steam charged to boiler house uses will increase, as will the total water to the boilers and the fuel to evaporate this additional water.

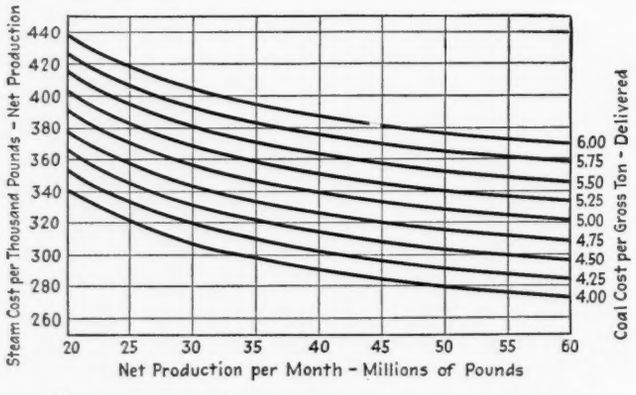

Fig. 1—Estimated operating costs (no fixed charges) of producing steam in coal-burning plant (steam cost in mills)

From these figures the cost per thousand pounds for net steam produced has been figured, this being given both for direct cost and for total cost, including fixed charges; therefore a comparison of the cost of producing steam by coal and oil under the assumed conditions is shown.

Because certain items, such as labor, remain constant regardless of production, and because the cost of fuel varies in accordance with fuel prices, it is generally advisable to plot curves to cover these varying conditions. Four curves have been prepared from the basic figures given here. Figs. 1 and 2 show the cost per

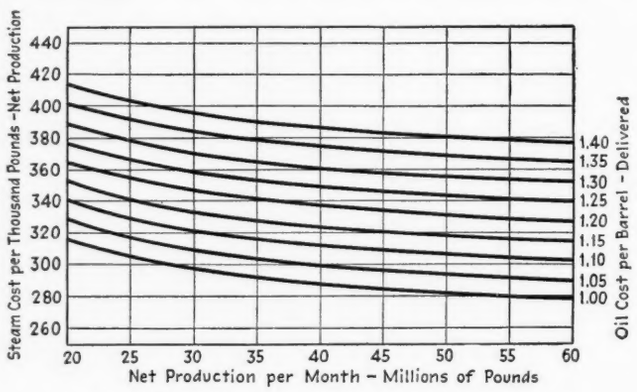

Fig. 2—Estimated operating cost (no fixed charges) of producing steam in oil-burning plant (steam cost in mills)

thousand pounds of steam, first for coal, and second for oil, both without fixed charges, while Figs. 3 and 4 cover the same conditions but include fixed charges.

To figure the costs under the varying conditions, the figures were divided into three groups: First, those varying directly with production; second, those which remain fixed regardless of production; third, those which vary according to fuel price. On this basis, different combinations of figures were obtained and plotted, the curves given here being the result. These curves give the cost of producing steam for evaporations ranging from 20,000,000 lb. to 60,000,000 lb. per month, and with fuel prices from $4 to $6 per gross ton delivered for coal, and from $1 to $1.40 per barrel for oil.

It will be noted that in general the cost of producing steam by coal falls off much more rapidly as the production increases than does the cost by oil. This is because the fuel cost in the case of oil is a much greater percentage of the total cost than is true in the case of coal. Therefore, since the heat cost of oil is normally above that of coal, it will generally be found that the cost of generating steam by coal will, at the higher productions, drop below the cost of generating by oil. For this

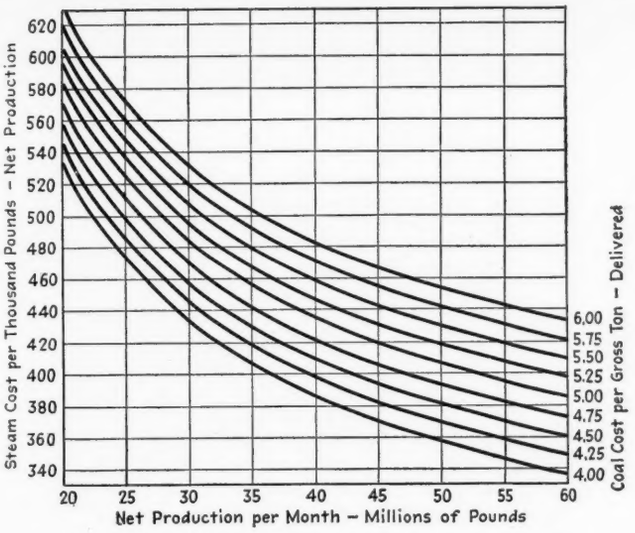

Fig. 3—Estimated total cost (including fixed charges) of producing steam in coal-burning plant (Steam cost in mills)

reason, in part, the central stations generating large quantities of steam usually find it more economical to burn coal even though an industrial next door might find it much cheaper to use oil.

I feel that it is impracticable to attempt to plot any curves which will fit all conditions, but I have attempted to give briefly a résumé of an assumed condition and to show how the curves to meet this condition were plotted. With this as a base, the average industrial plant should be able to estimate figures to suit its own condition and to plot curves similar to the ones shown here. These curves may be superimposed so that a direct comparison of the costs by the use of coal and oil is obtained.

It is also of some advantage at times, when discussing possible changes with the plant management, to have figures showing yearly loss or profit. These can be set down in convenient form as shown in Table II. The non-technical management can then see at a glance how many dollars will be saved or lost by making changes or by maintaining present conditions. As management is interested primarily in total yearly costs, such a tabulation is generally the best argument a plant engineer can bring up to justify expenditures for improvements.

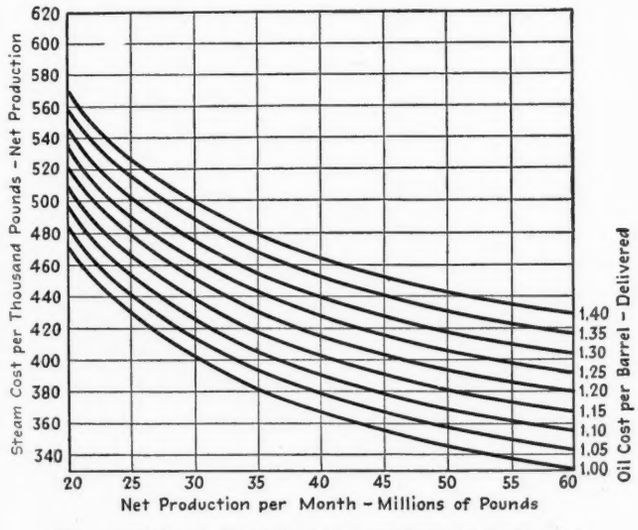

Fig. 4—Estimated total cost (including fixed charges) of producing steam in oil-burning plant (Steam cost in mills)

Use Averages With Caution to Avoid Erroneous Impressions

THE MAN who invented the phrase "lies, damn lies and statistics" evidently had a grudge to pay off. Nevertheless, it is true that statistics—even mathematically precise statistics—may give entirely erroneous impressions. Caution and intelligence are required in the use of all statistical devices. An example of particular importance to the engineer is the "average," or "mean."

Averages may be extremely useful or they may be merely misleading. As has been pointed out, a man may easily drown in a river whose average depth is six inches.

A common error is found in the averaging of unit costs. If power for one month costs 2c. per kilowatt-hour and for another 1.5c., the average cost is not necessarily 1.75c. That could happen only where the amounts of power used in the two months were equal.

Five dollars per ton is paid for one lot of coal and $6 for another lot. The average cost of coal purchased is $5.50 only in a case where the two lots are equal. A true average price is the total money paid for all the coal bought, divided by the total number of tons purchased.

The true average cost of electricity in the previous example is the total cost of all electricity produced in the two months divided by the total number of kilowatt-hours. To put it in another way, this total cost is the number of kilowatt-hours generated in one month multiplied by the unit cost for that month plus a similar product for the other month.

All this is rather elementary and many engineers would never make the mistakes illustrated. It is, however, common to find other misuses of averages. For example, attempts are made to measure a pulsating flow through an orifice by reading the average position of the manometer or by throttling the manometer so that it will give a steady reading. Velocities or flows computed from such data are not reliable if the fluctuations are wide. The reason is that flow varies as the square root of the pressure difference. In practical engineering work it is best to avoid or dampen the rapid variations in flow.

Another error, far more serious, is sometimes made. In studying the possibilities of extracting power as a byproduct of process steam, one frequently encounters cases where average steam flows and average kilowatts are used. There is little value in such a study that does not take into account the hour-by-hour variation of the two loads. One load may be heavy in the morning and the other in the afternoon. Averaging the whole day to get hourly loads shows nothing about these relative positions of peaks and valleys, and may lead to entirely wrong conclusions.

It is, of course, necessary in such studies to make some use of averages. The past must be used as a guide to the future. This requires making use of average or typical results.

In the case of the power-process steam study it would seem most practicable to choose four seasons and pick in each a day that was normal from the point of view of outside temperature, process demand and power demand. For each of these typical days curves should be plotted showing the hourly variations in steam and electrical demand.

Assuming a given method of producing or purchasing current (or both) it would be possible to make a reasonable prediction of actual costs.

Measuring Transformer Temperature

By B. A. BRIGGS
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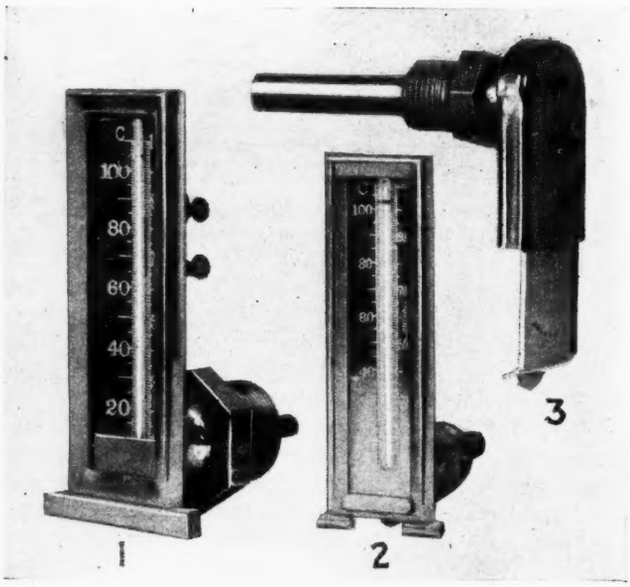
Because of their construction, transformers present special problems in temperature measurement. Ordinary thermometers, maximum temperature indicators, resistance thermometers with an artificial hot-spot in the oil, and resistance units placed in the low-voltage windings are some of the devices used to obtain the temperature of the windings



FIGS. 1 TO 3—DEVICES FOR INDICATING THE TEMPERATURE OF TRANSFORMERS

Fig. 1—Thermometer with connections for ringing an alarm. Fig. 2—Plain thermometer for connecting into the side of a transformer's tank. Fig. 3—Temperature indicator operated by a bimetallic strip.

TRANSFORMERS should be operated so that their temperatures do not exceed specified limits. The limit for the hottest spot in the copper is 105 deg. C. This is the maximum temperature to which fibrous insulation may be subjected continuously. Excessive temperatures cause rapid deterioration of the insulation, discolor the oil and cause it to sludge. For these reasons it is desirable to keep a check on transformer temperatures.

In addition to knowing the temperature of transformers as an insurance against damage from overheating, there are other reasons for keeping a check on the heating of the windings. When the ambient temperature is low, the loading of transformers may be increased beyond normal rating. As an example, approximately 1 per cent increase can be obtained in the kilovolt-ampere capacity of transformers for each degree that the ambient temperature is below 40 deg. C. without exceeding the 105 deg. hot-spot limit. When the load is variable, short-time overloads may be carried.

With water cooling, if the temperature of the water is below 25 deg. C., transformers may be loaded beyond normal. If the load is below normal the amount of cooling water may be reduced. For each degree Centigrade the temperature of the ingoing cooling water is below 25 the capacity of the transformer is increased approximately 1 per cent. With a given load on a transformer, only about 50 per cent as much water at 15 deg. C. is required for cooling as when the water has a temperature of 25 deg. C. To safely take advantage of this it is necessary to have an accurate indication of the transformer's temperature.

With medium- and small-sized power transformers, ordinary indicating thermometers may be used, such as shown in Figs. 1 and 2. The thermometer in Fig. 2 is the plain type, whereas the design in Fig. 1 has two contacts to which an alarm circuit may be connected to ring a bell should the temperatures exceed a safe limit.

In many applications plain thermometers are not satisfactory, either because they are not convenient to read or because they do not give a sufficiently accurate indication of the transformer's temperature. Where distribution transformers are located on poles a temperature-indicating device that can be read from the ground is desirable. On large transformers ordinary thermometers do not give a sufficiently accurate indication of the windings' temperature.

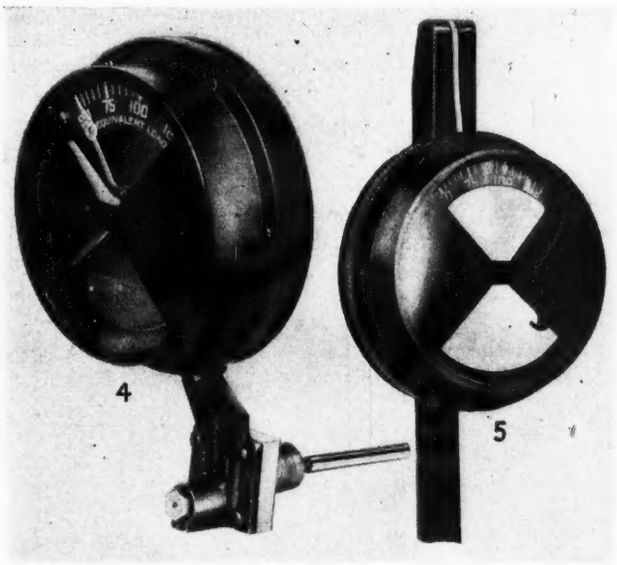
The device in Fig. 3 is designed to show when the temperature of a transformer has exceeded a safe limit. A hollow plug is screwed into the transformer case, so that its end projects into the oil. This plug carries a bimetallic strip which when cold supports a small semaphore within the indicator case at the end of the plug. If the temperature of the oil reaches the limit for which the indicator is adjusted, the bimetallic strip bends sufficiently to release the semaphore and it drops into view.

The indicator can be set to trip the semaphore for any temperature between 50 and 100 deg. C. in steps of 10 deg. As commonly applied, the object is to have the signal trip when the hottest part of the winding has reached a temperature of approximately 105 deg. C. Since the indicator responds to the temperature of the

oil in which the plug is immersed, it is necessary to adjust it to allow for difference in the temperature of the oil at the top and the bottom of the tank. At the top of the tank the oil is usually assumed to be 10 deg. hotter than at the bottom. The A.I.E.E. standardization rules allow 10 deg. C. between the hottest spot in the copper and the average temperature of the windings. An allowance of 15 deg. C. is usually made between the average temperature of the copper and the hot oil at the top of the tank. Taking these figures into account and allowing a hot-spot temperature of 105 deg. C., the indicator, if located in the top of the oil, would be set for 80 deg. final temperature, and 70 deg. final temperature if it were connected to the bottom of the tank.

Allowing 10 deg. between the hot-spot and the average temperature of the copper, the average temperature is 105 — 10 = 95 deg. Assuming the temperature of the top oil to be 15 deg. less than the average copper temperature gives an oil temperature of 95 — 15 = 80 deg., for which the indicator should be set. If the indicator is connected into the bottom of the tank, where the oil is assumed to be 10 deg. cooler than at the top, it should be set for 80 — 10 = 70 deg.

The foregoing settings are based on an ambient temperature of 40 deg. C. If the ambient temperature is

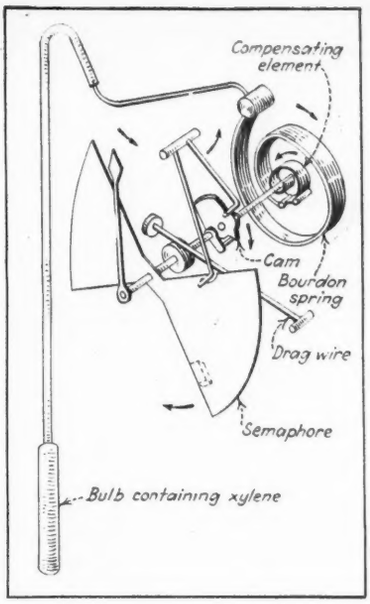


Figs. 4 and 5—Transformer load indicators for pole and subway service

less it should be taken into account when setting the indicator. The table shows manufacturer's recommended settings for different ambient temperatures and the per cent of full-load corresponding to each. For example, if the ambient temperature is 20 deg. C. (68 deg. F.) the indicator, when in the oil at the top of the tank, should be set to trip for 71 deg. C., or at 61 deg. if connected into the bottom of the tank. This will allow the transformer to carry a continuous load of 117 per cent of its nameplate rating.

For average conditions it will be satisfactory to set the indicator to trip when the oil at the top of the tank reaches 80 deg. C., and 70 deg. for the bottom of the tank. Much lower ambient temperatures exist in the winter months than in the summer, but it should not be necessary to reset the indicator, inasmuch as the lower ambient temperature automatically prevents the transformer from heating excessively.

Characteristics of the load supplied by the trans-



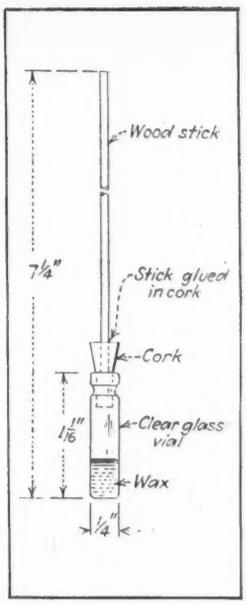


Fig. 6 (Left)—Diagram of the transformer load-indicator's mechanism, Figs. 4 and 5

Fig. 7 (Right)—Wax in a small bottle used as a temperature indicator

former affect the temperature gradient between the copper and the oil. The foregoing settings of the indicator are based on continuous load conditions. Although transformers can carry overload temporarily without overheating, the indicator should be set for a slightly lower temperature when the transformer has to supply peak loads.

Figs. 4 and 5 show a transformer load indicator that records the maximum per cent of full load on the transformer and will flash a danger signal if safe loading is exceeded. It will show underloading as well as overloading, and it indicates the load conditions at the time of reading and resetting.

The instrument consists, essentially, of two thermometers connected in series. One is of the capillary tube type and is immersed in the oil, and the other is of the bimetallic type and is located in the instrument's case to correct for the ambient temperature. The combination operates a pointer and a semaphore, as indicated in Fig. 6. As the temperature of the oil increases, the Bourdon spring expands and turns the cam in a clockwise direction. This cam makes contact with the indicator shaft and also turns it in the same direction. A drag wire rests on a little pulley on the pointer's shaft and holds it in the position of maximum equivalent continuous load on the transformer during a given period. The upper part of the cam operates a trigger that releases the semaphore to flash into view when a safe loading has been exceeded. The semaphore is normally out of sight until 100 per cent of the transformer's capacity has been exceeded, when it drops into view. The pointer is of the maximum reading type and records the maximum percentage of transformer capacity that has been utilized since the last setting, the scale being graduated to read between 50 and 125 per cent transformer capacity. This capacity is that limited by the internal winding temperature (hot spot) of the transformer. In cold weather an indication of the safe load on the transformer may be well above the nameplate rating.

Indicators are made in two types, as shown in Figs. 4 and 5. To install the indicator in Fig. 4 on pole-type transformers it is only necessary to unbolt and lift one

side of the transformer's cover, slip the instrument's support over the edge of the tank and replace the cover. The indicator in Fig. 5 is for subway-type transformers and is connected into an oil-campling plug hole.

A small glass vial containing wax, Fig. 7, has been used to determine when distribution transformers have exceeded a given temperature. The vial is placed in a horizontal position in a receptacle extending into the oil for a short distance near the top. When the temperature reaches the melting point of the wax the latter changes its position in the vial and serves as an indicator. Even though the wax may harden after the safe temperature has been exceeded, the changed position of the wax shows that an overload existed. Three kinds of wax are used, spermacetti that has a melting point of 120 deg. F., beeswax that melts at 145 deg., and a mixture of beeswax and carnauba wax with a melting point of 180 deg. This device is simple and is adaptable to transformers located where they can be readily inspected.

On large transformers thermal indicators of the dial types, Figs. 8 and 9, are used extensively. These instruments consist of a Bourdon gage connected to an alcohol thermometer the bulb of which is located in the region of the hottest oil in the transformer. The gage is calibrated in degrees Centigrade, and a continuous indication of the transformers temperature is given by a black hand. A red hand actuated by the movement of the black one records the maximum temperature reached between readings. After a reading is taken the red hand may be reset by a knob on the front of the case. This indicator may also be equipped to ring an alarm bell when a safe temperature is exceeded, in which case the black hand carries an insulated cam that at a predetermined temperature closes a pair of spring-supported electrical contacts to sound the alarm. The instruments are designed, Fig. 8, to install the thermometer through the side of the tank, as in Fig. 10, or they are arranged, Fig. 9, so the thermometer may be installed in the top of the tank and the instrument placed on the side of the tank, where it can be conveniently observed, as in Fig. 11.

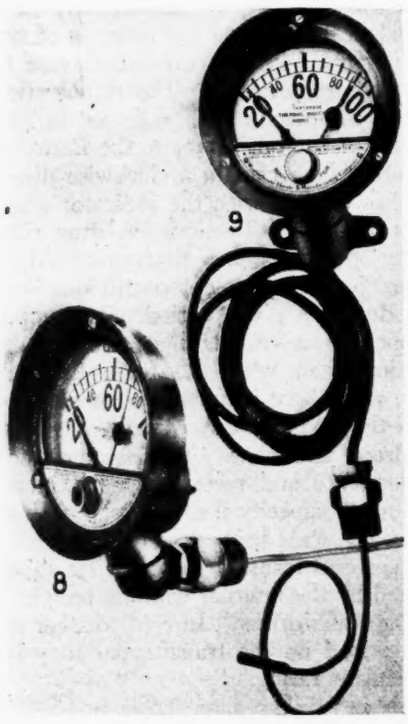
RECOMMENDED SETTING OF TEMPERATURE INDICATOR FOR DIFFERENT AMBIENT TEMPERATURES

Ambient Temperature Deg. F.	Ambient Temperature Deg. C.	Hot Oil Temperature Deg. C.	Hot Spot Winding Temperature Deg. C.	Per Cent Continuous Full Load
14	—10	57	105	139
32	0	62	105	132
50	10	66	105	125
68	20	71	105	117
86	30	75	105	109
104	40	80	105	100
122	50	84	105	90

In large transformers, measuring the oil temperature does not give a sufficiently accurate indication of the heating of the windings. In case of heavy overloads of short duration the large volume of oil may be heated very little, while the copper may reach a dangerous temperature. Furthermore, thermometers or other temperature-indicating devices cannot be placed close enough to the windings to determine the temperature of the copper without exposing to high potentials persons who may come close to the transformer.

Several methods have been developed to obtain the copper temperature of large transformers' windings. One is the use of a copper resistance unit consisting of two insulated wires wound on a thin core to form a strip several feet long. This resistance unit is wound in between the strands or between turns of a coil. The coil is located in the transformer where the highest temperature is expected. To insulate the resistance unit from the indicating or recording device its leads are connected to one winding of a small insulating transformer, as in Fig. 12. The other winding of the insulating transformer is connected to a bridge circuit, Fig. 14. The secondary of the bridge transformer forms two arms of the bridge. A fixed resistance R' and the primary of the insulating transformer form the other two arms of the bridge.

The stationary coil of the temperature indicator is connected across points C and D and its movable coil is connected to points A and B. When a voltage E is applied to the primary of the bridge transformer a potential Es is induced across point CD. Three circuits exist



Figs. 8 and 9—Dial-type thermometers for transformers

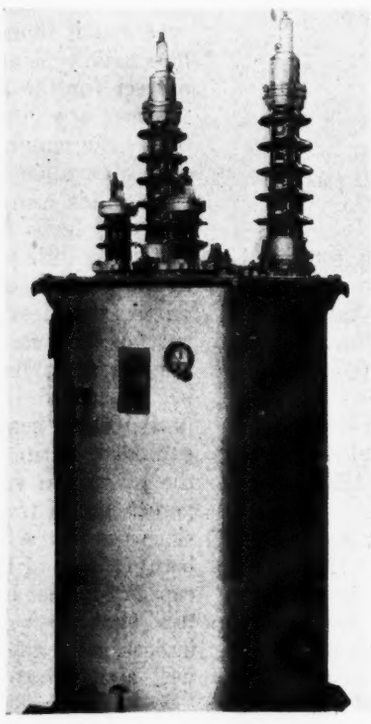


Fig. 10 — Dial-type thermometer installed in side of transformer

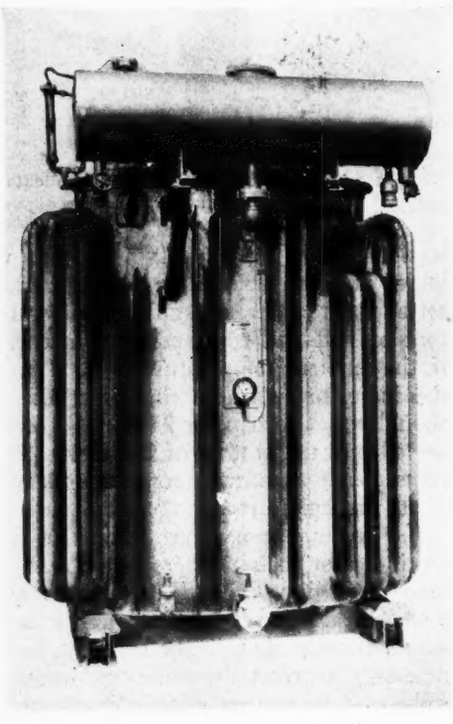
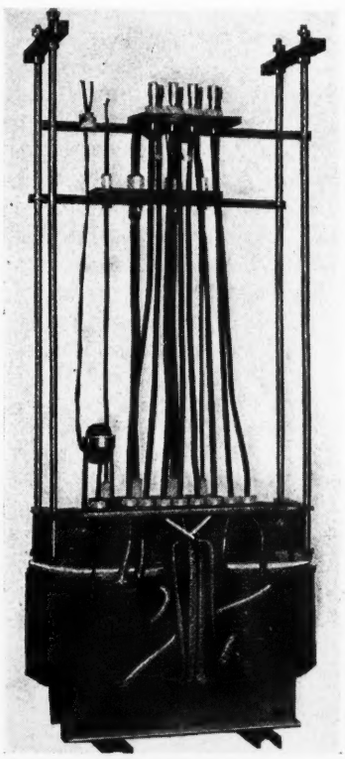


Fig. 11 — Dial-type thermometer installed on large transformer

through the bridge: One from C to D through the stationary coil of the indicator; another, CBD, through the fixed resistance R' and the primary of the insulating transformer; and the third circuit, CBA, through the fixed resistance R and the movable coil of the indicator. The current flowing through the primary of the insulating transformer will be influenced by the resistance of R. As the temperature of the transformer coil in which R is imbedded changes, the resistance of R will change and vary the current in the insulating transformer. This will affect the balance of the bridge and change the current through the movable coil and the temperature reading. By properly calibrating the indicator it will read the temperature of the transformer in degrees Centigrade. Instead of an indicating, a recording instrument may be used. The indicator and its accessories are mounted on a panel and provided with plug-switch receptacles, Fig. 13, so that the indicator may be connected to the temperature coils of several transformers or to the windings on the different legs of the same transformer.

The resistance units are placed in the low-voltage windings and are applied to windings operating at as



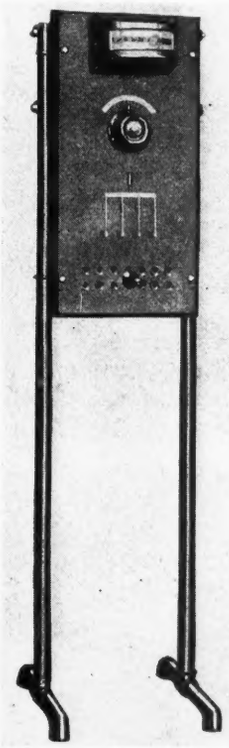


Fig. 12—(Left)—Insulating transformer on the left above main transformer's core

Fig. 13 (Right)—Transformer temperature indicator panel

high as 73,000 volts. Although it is possible to have the temperature of the high-voltage winding higher than the low-voltage winding, this feature is under the control of the designer. In modern transformers the temperature is practically the same in both windings. One of the advantages of the system is that anything that may affect the heating of the transformers is reflected to the heating coil, and the increase in temperature for a given load is indicated on the instrument.

Another method of measuring the temperature of large transformers is by a hottest-spot indicator. The thermometer type, a diagram of which is shown in Fig. 15, consists of an indicating dial thermometer with a high-resistance metal bulb and a current transformer. The current transformer is mounted inside the case of the power transformer and is energized by one of the windings of the power transformers. The secondary of the current transformer is connected to the metal bulb of the transformer, which carries a current proportional to the load on the main transformer. The bulb is located in the hottest part of the oil, and since it is

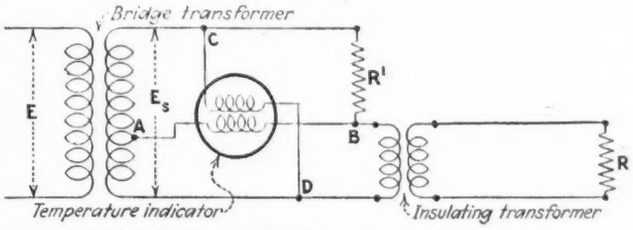


Fig. 14—Diagram of alternating-current bridge-type temperature indicator

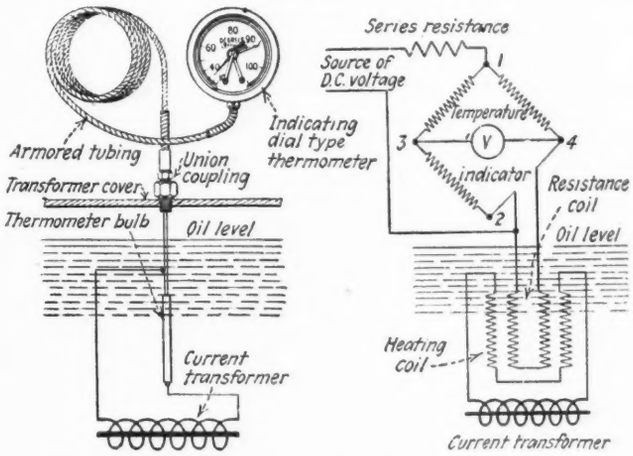


Fig. 15 (Left)—Hottest-spot temperature indicator for transformers

Fig. 16 (Right)—Diagram of bridge-type hottest-spot temperature indicator

heated by current from the current transformer it can be designed to reproduce the temperature of the hottest spot in the main transformer windings. Surrounding the bulb is an insulating tube of such thickness that the difference in temperature between the oil and the bulb is the same as that between the transformer windings and the oil. Thermometers used with the heating coil are calibrated to read 10 deg. C. higher than the temperature of the heating coil and thus show the hot-spot temperature of the transformer's winding.

Where it is desired to have an indication or record of a transformer's temperature at a remote location, a resistance coil is placed inside a heating coil, as in Fig. 15. The heating coil is connected to form one arm of a Wheatstone bridge, and the temperature indicator or recorder is connected across the bridge. A change in temperature of the resistance coil changes its resistance and affects the balance of the bridge and the current through the instrument. The latter causes the meter's needle to take a new position corresponding to the change in temperature. The instrument is calibrated to give a reading 10 deg. C. higher than the temperature inside the heating coil and therefore to make the 10 deg. hot-spot allowance. The meter, which may be either an indicating or a recording type, is arranged for switchboard mounting. By means of a multipoint switch the temperature of a number of transformers may be read on one instrument.

Economics of the Use of Diesel Engines for Power Generation*

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Unit, investment, and operating cost figures, and a complete tabulation of the results obtained in three different practical solutions of a specific problem

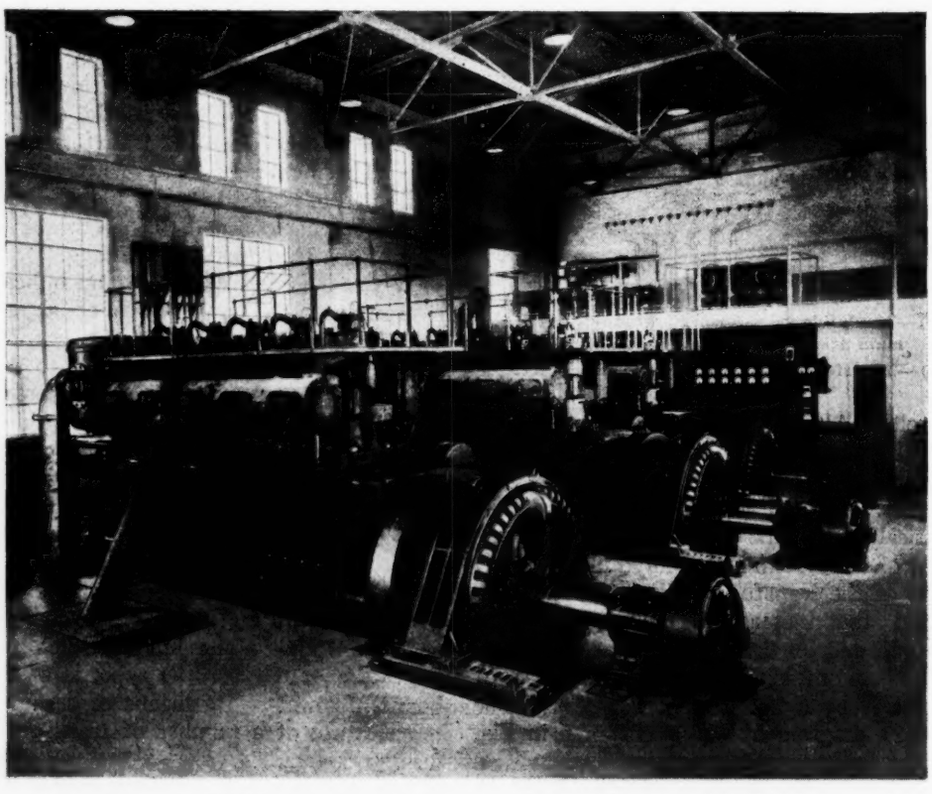
IN CONSIDERING use of Diesel-electric generating units in the production of electric power for distribution and sale, the economic side of the situation is probably of the greatest concern. With this thought in mind, the author has assembled and is presenting tabulated figures of investment and operating costs which are representative of his experience.

The figures presented, therefore, should be accepted merely on the basis of one man's experience in the Southwestern section of the United States. It is felt, however, that, with slight modification for variations in conditions which may be encountered in other localities, these figures may be accepted in the study of the production and distribution of electric energy in any section of the country. Unit values will be subject to some little variation under different conditions peculiar to the specific location.

In presenting a solution for a typical problem which may be met in the electric-utility industry, the purpose is to outline a method of attack in the consideration of such a problem rather than to indicate a correct solution. The great number of variable quantities and values involved makes possible many different solutions, some one of which will likely be the best in the specific case but others of which may have considerable merit.

The cost of Diesel-electric plants of similar capacity will vary between rather wide limits, with local conditions affecting the design and other conditions affecting construction. It will also vary to a considerable extent

*Abstract of paper presented at the Third National Oil and Gas Power Meeting, A.S.M.E., State College, Pa., June, 1930.



with the type of structure selected for the plant, and in case provision is made for installation of additional equipment at some later date the cost may be increased quite materially. In Table I are estimated costs of seventeen different Diesel-electric generating plants of representative design and varying in installed capacity from 117 kw. to 10,110 kw. The cost of the plant has been subdivided into five different accounts, which follows the N.E.L.A. classification. Certain assumptions have to be made in the selection of equipment for the plants and in the selection of the type of structure. The designs on which these estimates are based and the cost of the installations are consistent with actual experience in the construction of many similar plants.

Plants 1 to 6, inclusive, are equipped with two-stroke-cycle airless-injection engines; other plants have two-stroke-cycle and four-stroke-cycle air-injection engines. Plants 1 to 5, inclusive, are equipped with open-type water-cooling systems, and others with closed-type systems and heat exchangers. Plants 1 to 4, inclusive, are housed in wood-frame structures covered with corrugated metal; 5 to 8, inclusive, are housed in steel-frame structures with corrugated asbestos covering. Plants 9 to 17, inclusive, are housed in steel-frame structures with brick walls, of fire-resisting roof construction, and with modest exterior decorations. In general, the structures have been made large enough to accommodate one additional generating unit. All the engines have sea-level ratings; however, loss of power due to increase in elevation will not be sufficient to affect the values to any appreciable extent below 3,500 ft. elevation.

The overhead costs have been taken as 15 per cent in all cases, overhead being understood to cover administrative expense, cost of financing, engineering, superintendence, cost of purchasing and storing material, construction accounting, interest, and insurance during construction. Detailed estimates have been prepared on all of the plants listed, but it has not been found practicable to include the details here. Cost of the various items of equipment is based on recent quotations, and the point of delivery selected is Texas.

In studying the cost of producing and distributing electric current, it becomes necessary to know the cost of transmission lines, transformer substations, and distribution systems. The cost figures used were based on finished designs and actual construction, and were representative of good practice in the Southwest. Sufficient grounds were covered in these cost tabulations for selection of all facilities required in the solution of a problem to be discussed later.

The next item of interest after investment is cost of operation. In Table II there are presented representative operating and maintenance cost figures and unit economy figures for each of the Diesel-electric plants listed in Table I. The figures are based on average good results obtained in the use of such plants in electric utility operation. No attempt has been made in this tabulation to show results other than those that can be and have actually been obtained, and which under normal circumstances are representative of the various types of plants listed. Fuel oil is of 18,500 B.t.u. heat content and of gravity and viscosity best suited to the type of engine in which it is burned. Figures appearing in this tabulation will be used later in the solution of a problem to be discussed.

Under operating costs the matter of fixed charges on investment must be considered. Here a figure of 13.5 per cent has been selected, consisting of 6 per cent interest, 6 per cent depreciation, and 1.5 per cent for insurance and taxes. This figure is applied to the total investment both in plant and distribution facilities and may therefore be considered as average.

In studying the application of Diesel-electric plants to electric utility systems, it is necessary to have some knowledge of the characteristics of the loads to be served. Consideration was given to electric service in small and moderate-sized towns, with populations from 500 to 5,000, and the number of electric connections varied correspondingly from 100 to 1,000.

In distribution systems such as those considered, it has been found by analysis and calculation that the losses will be divided up about as follows: Transformer core loss, 35 per cent; transformer copper loss, 25 per cent; line loss, 40 per cent. The transformer core loss energy will have a load factor of 100 per cent, and therefore the yearly maximum demand of this loss will be the kilowatt-hour yearly loss divided by 8,760. On the assumption that the maximum load current is on the line 14.3 per cent of the time, one-half of the maximum load current is on the 28.5 per cent of the time, and one-quarter of the maximum load current is on the line 57.2 per cent of the time, it is found that 57.2 per cent of the transformer copper loss and the line loss occur during the period of maximum loads, and therefore the yearly maximum demand of these losses will be the kilowatt-hour yearly loss divided by 2,190.

Power-factor conditions in the system vary to an extent depending on the nature of the locality. It is interesting to note that, under the assumptions made, the yearly load factors of the towns fluctuated from 15.5 per cent

TABLE I—REPRESENTATIVE COSTS OF DIESEL-ELECTRIC GENERATING PLANTS

Plant No.	Generating Units: No.	Capacity: Hp.	Capacity: Kw. Each	Capacity: Total Kw.	Cost, Dollars: Land	Structures	Engines	Elec. Plant	Aux. and Access.	Total	Cost per Kw. Gen. Capy.
1	1	60	39	.....	.....	.....	.....	.....	.....	.....	.....
	1	120	78	117	1,000	3,758	14,920	8,659	4,777	33,114	283
2	2	120	78	156	1,000	3,758	19,388	9,583	5,457	39,186	251
3	2	180	117	234	1,000	6,713	27,990	10,531	7,304	53,538	229
4	2	240	157	314	2,000	7,220	35,246	13,878	10,753	69,097	220
5	3	180	117	351	2,000	11,828	41,989	16,162	11,971	83,950	239
6	3	240	157	471	2,000	12,522	52,876	19,092	16,801	103,291	219
7	2	400	266	532	2,000	12,781	64,629	17,626	16,328	113,364	213
8	3	400	266	798	4,000	14,662	96,937	24,884	21,374	161,857	203
9	3	500	336	1,008	4,000	30,678	118,927	28,215	25,468	207,288	206
10	3	600	405	1,215	4,000	30,678	134,681	29,047	29,185	227,591	187
11	3	800	547	1,641	4,000	36,215	175,592	33,210	35,212	284,229	173
12	2	1,200	832								
	1	800	547	2,211	4,000	42,717	217,678	34,745	44,885	344,025	156
13	3	1,200	832	2,496	4,000	42,717	239,569	38,616	46,092	370,994	149
14	3	1,800	1,248	3,744	8,000	45,002	360,969	55,470	55,579	525,020	140
15	2	1,800	1,248								
	2	2,400	1,685	5,866	8,000	55,990	553,240	75,507	75,181	767,981	131
16	5	2,400	1,685	8,425	8,000	62,005	781,760	96,160	93,991	1,041,916	124
17	6	2,400	1,685	10,110	8,000	68,668	938,023	113,492	108,213	1,236,396	122

in a town of 100 connections to 37.5 per cent in a town of 1,000 connections, and similarly the energy demand per connection varied from 0.27 kva. to 0.975 kva. These figures on load are presented as fairly representative of conditions to be found in the less thickly populated sections of the country, and will be used as a basis for the load assumptions in the specific problem to be presented.

To give a concrete illustration of the probable investment and operating costs of a complete system for the production and distribution of electric energy with energy produced in Diesel plants, three solutions of the problem selected are presented for comparison. The problem consists of producing and distributing energy to 15,700 customers in 60 different towns with the number of connections in the towns varying from 100 to 1,000 and the towns located within an area of about 125 by 140 miles.

In solution *A* the towns to be served have been divided up into 21 different groups or individuals, and are served with energy from 21 different plants. This may be called the individual plan system wherein a plant is installed in every sizable town and no attempt is made to transmit energy except in small quantities to adjacent towns.

In solution *B* the towns to be served have been divided into six separate groups, each one of which is served from a plant similarly located in the largest town within the group. This arrangement may be called the local group-plant system. In this system considerable use is made of transmission lines of intermediate voltage serving towns a considerable distance away from the generating plant.

In solution *C* a single plant has been installed and all towns have been interconnected by means of a transmission network system. All transmission lines and transmission substations have been designed with ample capacity to serve the loads indicated with voltage regulations at point of delivery within satisfactory limits. Present-day requirements are exacting to such a degree that a high standard of service is required both in regard to voltage regulation and continuity. The systems as laid out followed good engineering practice.

It was found that in solution *A* the total amount of energy lost in transmission and distribution was 13.1 per cent of that delivered from the plant. In solution *B* the percentage was 15.1 per cent, and in solution *C* 17.6 per cent. This appears to work out in about the correct proportion found in actual operation. There will be a further loss occasioned by imperfect metering and theft of current which will raise the percentage to some little extent; however, no allowance is made here for such losses.

All transmission lines were assumed to be constructed of aluminum conductor, steel reinforced, on account of its lower cost than copper. Some slight variation in the costs of electric distribution systems for the three solutions will be found on account of changes in voltage for certain of the towns in the different group arrangements. In all instances where a stepdown substation with 6,600 volts or 6,900 volts secondary is serving more than one town, the local distribution as well as that of other towns served has been built for 6,600-volt operation, and, in fact, all towns served by transmission lines at 6,600 volts are provided with 6,600-volt distribution systems.

TABLE II—REPRESENTATIVE OPERATING AND MAINTENANCE COSTS AND ECONOMIES OF DIESEL-ELECTRIC POWER PLANTS

Plant Number	Generating Units		Total Plant Capacity		Auxiliary Power		Plant				Repairs to Diesel Engines					
	No.	Hp.	Hp.	Kw.	Kw.-Hr. per Hp. per Yr.	Kw.-Hr. per Yr.	Fuel Economy, Kw.-Hr. Gen. per Gal. Fuel	Lubr. Oil Economy, Kw.-Hr. Gen. per Gal. Lubr. Oil Used	No. Employees	Rate per Month	Labor Total Cost per Yr.	Misc. Supplies Dollars per Yr.	Dollars per Hp. per Yr.	Total per Yr.	Maint. of Bldgs. and Grounds Dollars per Yr.	Maint. of Electric Equip. Dollars per Yr.	Maint. of Pr. Plant Aux. Equip. Dollars per Yr.
1	1 1	60 120	180	117	120	21,600	6	215	1 1	135 100	2,820	200	3.40	612	36	87	72
2	2	120	240	156	120	28,800	7	267	1 1	135 100	2,820	240	3.15	757	36	96	82
3	2	180	360	234	120	43,200	8	570	1 2	135 100	4,020	330	2.75	990	58	105	110
4	2	240	480	314	120	57,600	8.5	740	1 2	150 100	4,200	410	2.25	1,080	69	139	161
5	3	180	540	351	120	64,800	8.5	880	1 2	150 115	4,560	445	2.05	1,105	104	162	180
6	3	240	720	471	120	86,400	9	1,120	1 2	150 125	4,800	540	1.60	1,150	109	191	252
	2	400	800	532	120	96,000	11	1,220	1 2	160 125	4,920	560	1.50	1,200	111	176	245
8	3	400	1,200	798	120	144,000	11	1,440	1 2	175 125	5,100	710	1.24	1,488	140	249	321
9	3	500	1,500	1,008	119	178,500	11	1,490	1 3	175 125	6,600	810	1.15	1,725	260	282	382
10	3	600	1,800	1,215	119	214,200	11	1,510	1 3	200 135	7,260	920	1.14	2,055	260	290	438
11	3	800	2,400	1,641	115	276,000	11	1,530	1 3	200 150	7,800	1,080	1.12	2,688	302	332	528
12	1 2	800 1,200	3,200	2,211	110	352,000	11	1,550	1 3	225 150	8,100	1,200	1.11	3,552	350	347	673
13	3	1,200	3,600	2,496	108	388,800	11	1,570	1 1 2 1	225 175 150 100	9,600	1,260	1.11	3,996	350	386	691
14	3	1,800	5,400	3,744	102	550,800	11	1,610	1 1 2 1	250 175 150 100	9,900	1,430	1.10	5,940	398	555	834
15	2 2	1 800 2,400	8,400	5,866	100	840,000	11	1,680	1 1 3	275 175 150	10,800	1,890	1.10	9,240	480	755	1,128
16	5	2,400	12,000	8,424	98	1,176,000	11	1,700	1 2 3	300 175 150	13,200	2,640	1.10	13,200	525	962	1,410
17	6	2,400	14,400	10,110	96	1,382,400	11	1,700	1 2 3	300 175 150	13,200	3,020	1.10	15,840	575	1,135	1,623

TABLE III—TOTAL INVESTMENT FOR EACH OF THREE SOLUTIONS OF PROBLEMS PRESENTED

	Solution "A"				Solution "B"				Solution "C"			
	Cost in dollars	Per cent	Cost per connection in dollars	Cost per million kw.-hr. delivered per year in dollars	Cost in dollars	Per cent	Cost per connection in dollars	Cost per million kw.-hr. delivered per year in dollars	Cost in dollars	Per cent	Cost per connection in dollars	Cost per million kw.-hr. delivered per year in dollars
Power plants	2,484,929	56.3	158.28	126,305	1,885,220	43.5	120.08	95,821	1,236,396	27.4	78.75	62,843
Transmission lines	659,681	15.0	42.00	33,531	1,129,047	26.0	71.91	57,387	1,805,278	40.0	114.98	91,758
Transm. substations	67,329	1.5	4.29	3,422	125,654	2.9	8.00	6,387	235,933	5.2	15.03	11,992
Sectionalizing and control switches	8,769	0.2	0.56	448	15,117	0.3	0.96	768	58,717	1.3	3.74	2,984
Distribution systems	1,188,250	27.0	75.68	60,396	1,181,800	27.3	75.27	60.068	1,179,150	26.1	75.10	59,934
Total	4,408,959	100	280.81	224,102	4,336,838	100	276.22	220,431	4,515,474	100	297.60	229,511

NOTE: Total investment to serve to 15,700 connections 19,674,290 kw.-hr. per year for each of the three solutions of the problem.

It was rather disconcerting to find that there is but slight variation of total costs in any of the three solutions. Solution *B* with the local group-plant arrangement is the least expensive, with a total cost of $276 per connection, while solution *C* is the most expensive, with a total cost of $297 per connection. The percentage of total investment, however, in each of the various parts of the system varies between wide limits. In solution *A* for instance, power plants constitute 56 per cent of the total investment, whereas in solution *C* they constitute only 27 per cent.

Final results of this study are embodied in annual operating cost figures for each of the three solutions in Table IV. In this table all operating costs considered, plus fixed charges on total investment, have been brought together to a final figure and divided by the amount of energy delivered to the customers. In spite of the fact that plant production costs vary from 3.39c. in the smallest plant to 0.44c. per kilowatt-hour in the largest, the difference in final costs per kilowatt-hour delivered to customers in all solutions is rather close together. It can be pointed out that consideration has not been given to all expenses incident to operation of this group of properties, inasmuch as no allowance has been made for superintendence and administrative expenses, nor for meter reading, accounting, advertising, and legal expenses. These items have been purposely omitted, since they are not affected directly by the type of system installed. Although solution *C* shows a final cost figure one mill lower than solution *B*, there may be quite honest and well-supported differences in opinion as to which of these two solutions is the more desirable, weighing the relative hazards of transmission line operation as against power plant operation.

TABLE IV—ANNUAL COST OF OPERATION

	Solutions A	B	C
Kw.-hr generated	24,853,449	25,084,240	25,255,882
Kw.-hr. to plant aux.	2,212,800	1,910,000	1,382,400
Kw.-hr. net production	22,640,649	23,174,240	23,873,482
Fuel oil used, gallons	2,452,236	2,280,385	2,295,990
Fuel oil cost at 0.03 per gal., dollars	73,568	68,411	68,880
Lubr. oil used, gallons	22,781	16,168	14,856
Lubr. oil cost, dollars	10,873	8,084	7,428
Plant labor, dollars	99,970	49,920	13,200
Plant supplies, dollars	11,345	6,760	3,020
Repairs to Diesel engines, dollars	28,431	19,206	15,840
Maint. of bldgs. and grounds, dollars	2,570	1,920	575
Maint. of elect. equip., dollars	3,834	2,046	1,135
Maint. of plant aux. equip., dollars	4,959	3,604	1,623
Total production cost, dollars	235,540	159,951	111,70 b
Cost per kw.-hr. produced, cents	0.95	0.63	0.44
Maint. and oper. of transm. lines, dollars	8,197	12,998	17,901
Maint. and oper. of distrib. systems, dollars	50,720	50,720	50,720
13½ per cent fixed charges on total invest., dollars	595,209	585,473	609,589
Total oper. cost and charges, dollars	889,666	809,142	789,911
Total cost per kw.-hr., del'd. to cust., cents	4.52	4.11	4.01

In conclusion, it may be stated that nothing definite has been proved in regard to the use of Diesel plants. If in solution *C* a steam plant were used instead of a Diesel plant, there would likely be a slight difference in the cost per kilowatt-hour delivered, provided the two plants used the same fuel. No doubt the steam plant could be built at considerably less cost than the Diesel plant, with a resulting credit in fixed charges in the comparative operating cost statement. This credit, however, would be somewhat more than offset by the difference in cost of fuel and labor, since the steam plant probably would not generate more than 7 kw.-hr. per gallon of fuel, and the number of plant employees would be greater.

There is a definitely established field for Diesel plants where the capacity of the plant is small, where water and cooling conditions are unfavorable for condensing-turbine operation, where the site is relatively inaccessible, or where space available is extremely limited.

It is of more interest, however, to compare the Diesel plant with other types of plants for situations where none of the above conditions exists, strictly on a basis of operating and investment cost. On such a basis and in cases where there is no fuel cheaper than oil available, is would appear that the Diesel plant is on par with any other type of plant, provided the engines used are of a satisfactory design to give uninterrupted service when a proper maintenance schedule is followed. The success or failure of this type of prime mover, then, depends, in the final analysis, on the manufacturers of the engines. Adequate engineering, suitable design, proper selection of materials, good workmanship, and a willingness to stand behind their product in operation as well as in sales promotion should establish a high and important position for Diesel engine in the power field.

IN CANADA, central stations produce more than twice the number of kilowatt-hours per capita as do similar plants in the United States. Water power generates over 98 per cent of this output in Canada, where in the United States it supplies only about 36 per cent. How our northern neighbors are utilizing their water power in their present industrial expansion is told in the next number.

The Evolution of the Engine Indicator

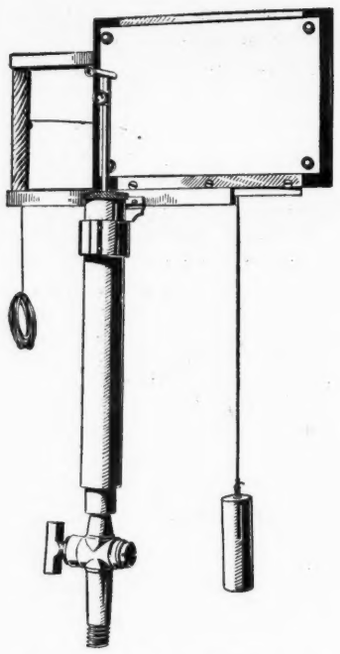


Fig. 1—Watt's sliding frame indicator

By J. B. M. CLARK

Although the indicator is almost as old as the steam engine, it is still the best present-day method of discovering engine trouble and should be used oftener than it is

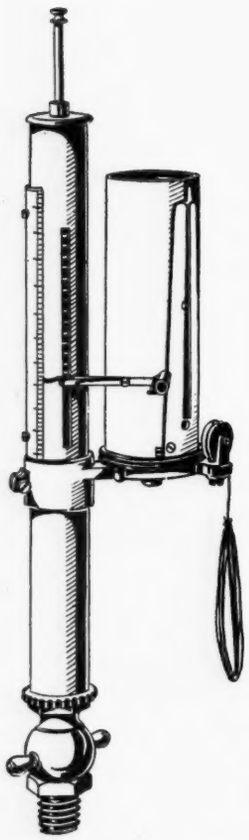


Fig. 2—McNaught introduced the drum

THE AVERAGE plant engineer looks upon the engine indicator and indicating gear as theoretical rather than practical devices, and so they are not used as frequently as they should be.

A customary statement is that the engine is developing power at the rate of so many pounds of coal per horsepower hour. This, of course, is no doubt the ultimate test of commercial efficiency, but it does not differentiate between the efficiency of the engine and that of the boiler. A good engine worked in combination with a bad boiler or a bad engine with a good boiler might show results in pounds of coal per horsepower per hour of an almost identical nature.

Power developed is only one of the many things revealed by the indicator diagram; as a matter of fact, the engineer who makes a study of these diagrams can tell almost anything about the performance of the engine from them.

It was not long after interesting himself in the steam engine that James Watt realized the necessity of obtaining some kind of idea of what was actually going on inside the engine cylinder. His inventive genius stimulated, Watt proceeded to meet this need, and thus the first engine indicator came into being. It is significant of the grasp of Watt's mind and of his knowledge of fundamentals that he should have hit upon the right basic idea, and that the steam engine indicator as we have it today with its cylinder, piston, spring, and pencil should be simply a modified and improved form of the crude apparatus which he developed.

Watt's first indicator consisted of a steam cylinder about one inch in diameter and six inches long communicating with the engine cylinder and fastened to a wooden or metal frame more than twice its length, and a spiral spring attached to the piston and the upper part of the frame, which controlled the motion of a pointer connected with the piston rod of the instrument and pointing to a scale.

But presently the need of a graphic record became apparent and a board was added to which a sheet of paper was fixed, and a pencil substituted for the pointer. In order to duplicate the back-and-forth motion of the engine piston this board was made to slide, being drawn one way by a cord leading to a reciprocating part of the engine, and pulled back again by a weight attached to its other end, as shown in Fig. 1.

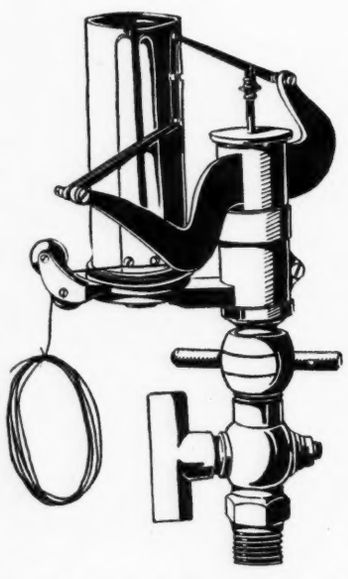


Fig. 3—The Richards indicator had a multiplying pencil motion

It is on record that a certain amount of secrecy surrounded Watt's indicator and its purpose, and only a limited number of people knew just what the apparatus was for. It is stated that one of his early engines was shipped to Russia, and after it had been there for some time a secret compartment was discovered containing the indicating apparatus, cylinder, piston, spring, board, and pencil. Nobody could make anything of this gear and a letter had to be written to the maker calling on him to explain just what it was.

The first improvement came with the advent of the McNaught indicator, Fig. 2, in which the reciprocating paper drum was introduced, but the long cylinder and pressure spring remained. Another early form with rather novel

features was the Maudslay, which strove to perfect the direct-acting principle. The cylinder was of large bore, open at the top, with a steam-tight piston. The motion of the piston was transmitted by means of a tube guided at the top end by side rods. This tube contained the pressure spring, which was prolonged to a cross piece at the extremities of the side rods. The pencil was fixed to an arm projecting from the guide at the top of the tube, and the reciprocating paper drum was employed. With the limited speeds and pressures of their day these instruments answered their purpose fairly well. But the demand for greater accuracy was beginning to arise, and about the middle of the nineteenth century Richards put on the market an instrument that held the field for the best part of 50 years.

In the Richards indicator, Fig. 3, the long cylinder was abandoned in favor of a short one of a relatively small diameter, having an area of only one-half square inch. The piston was not quite steam tight in the cylinder, which had the effect of reducing friction, and the movement of the piston was restricted to a distance of approximately three-quarters of an inch. Instead of being directly attached to the indicator piston the pencil was fitted to an arrangement of links and arms known as the multiplying motion. The upper end of the indicator piston rod connected with these links by means of a

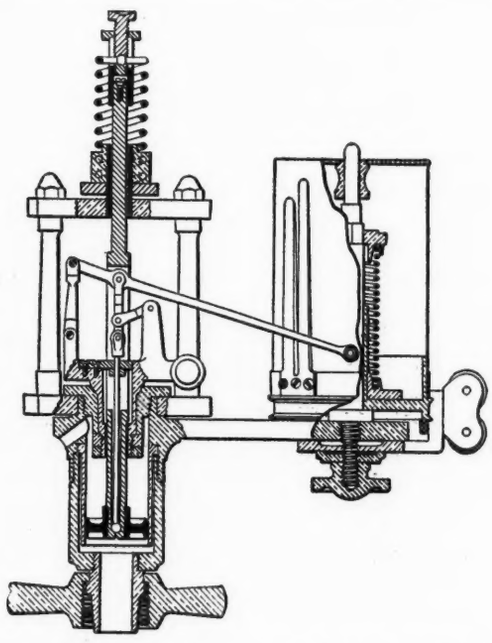


Fig. 4—A modern indicator for steam engines

swivel head, and in this way the travel of the piston was magnified on the diagram made by the pencil.

The latest models of the indicator are, in the main, improved and modified forms of the Richards. The moving parts have been lightened and improved multiplying motions designed, giving a ratio of pencil movement to piston travel of as much as 6 to 1. With the advent of superheated steam and high pressures the pressure spring has been taken outside of the steam cylinder altogether in the newer forms and exposed to the free air, so that the heat will not impair its accuracy. The volute spring for turning the paper drum has given way to a spiral spring that permits of adjustment of the tension, and many other improvements of an ingenious kind have been added to bring the instrument into line with modern requirements. Some makers turn out models of reduced size for high-speed work, and a good indicator is now part of the testing apparatus of any well-equipped plant where steam engines are in regular use.

The internal-combustion engine rendered still further modifications necessary. The moving parts had to be strengthened and cylinder diameters still further reduced.

An ingenious apparatus was designed some years ago for this particular purpose by Hopkinson, which marked one of the first radical departures in indicator design. The indicator cylinder and piston were retained, but the multiplying motion, paper drum, and pencil were abandoned in favor of a tilting mirror which threw a beam of light either on to a photographic plate for purposes of record or on to a graded screen where its movements could be observed with the naked eye. The spring is in the form of a straight steel bar of known strength attached direct to the piston rod, and the bending of this bar is communicated, by means of a thin piece of vertical steel, to a small mirror which tilts upon a horizontal axis. The framework supporting the mirror is arranged to move from side to side on a ball race, and, being positively connected to a reciprocating part of the engine, the equivalent of the motion of the ordinary reciprocating paper drum is secured. The advantages of such an apparatus for very high speeds are obvious.

As already stated, the engineer who has made a study of indicator diagrams can deduce almost anything about the engine's performance from them. Wire-drawing of steam due to insufficient size of steam pipe; restricted passages in stop valve, throttle valve, or ports; incorrect setting or design of steam or cut-off valves; leaky pistons or valves; throttled exhaust pipes or passages; insufficient or excessive compression—all are shown. In addition an analysis of the expansion curve, which calls for a good deal of arithmetical and geometrical knowledge, will enable the detection of wet steam, condensation, and re-evaporation.

All these things mean losses in efficiency, each small in itself perhaps but when added together making an

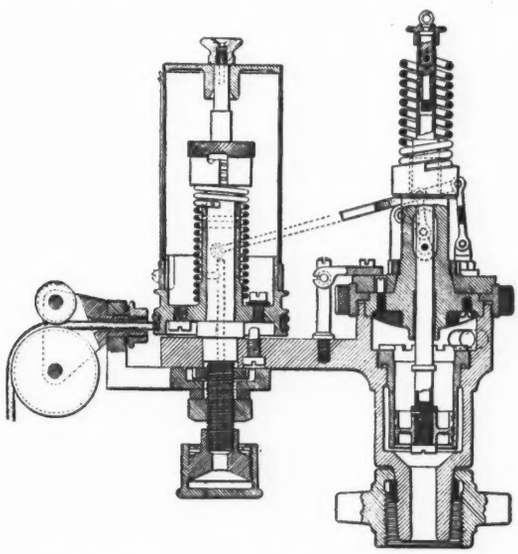


Fig. 5—This indicator is designed especially for oil engines

appreciable total. Any economies effected in the performance of the engine mean not only a saving in steam and a keeping down of the coal bill, but also small repair costs, absence of breakdowns, easy lubrication, minimum of depreciation, and longer life of the engine and machinery. Overloading and underloading, both highly uneconomical conditions of working, can also be detected,

and the amount of power taken up in driving the engine itself, that absorbed in driving various parts of the gearing and machinery, and the total available for doing work can all be ascertained. All are of the utmost importance.

Even in so unlikely a field, from the operator's point of view, as the railway locomotive there is much scope for the use of the indicator, and the difficulties in the way of its employment, which are supposed to be very serious, are by no means insuperable. If suitable provision for the operator in the form of a guard or cage be provided so that he can have the free use of both hands without danger of being thrown from the engine, diagrams can be taken from a given cylinder at the rate of one set per minute, which is not very far behind what can be done on a stationary high-speed engine. In some cases a sheet-iron box is fitted surrounding the front of the boiler and both cylinders so that there will be no annoyance from wind or flying missiles.

Special attention, too, has to be paid to the reducing motion, on account of the jarring of the engine, which is apt to interfere with the accuracy of the diagrams if not carefully watched. The reducing motion generally employed on locomotives is in the form of a solid lever securely attached to the crosshead, and some authorities recommend extra secure fastenings of the indicator to the cylinder, claiming that the ordinary connections as used on stationary engines are not strong enough. When one thinks of the amount of coal that locomotives use up, it is apparent enough that the correction of defects revealed by the indicator will mean a considerable saving on the yearly fuel bill.

At many plants steam engines are in operation that are never indicated from one year's end to another. Their working efficiency is gaged by rule of thumb. It is astonishing how firmly ingrained in the minds of many engineers is the notion that the indicator is a theoretical rather than a practical appliance. There are few cases on record where the regular use of the indicator does not result in annual savings more than equal to the price of the instrument.

▼ ▼ ▼

First Section of Sydney's New Municipal Plant Completed

ON JAN. 2, 1929, a portion of the first section of the power station at Bunnerong, Botany Bay, for the Sydney (Australia) City Council was put in operation and the whole section is now completed and in service. The estimated cost of the first section, to consist of an installation capable of meeting a demand of 100,000 kw., was $16,821,240. The actual cost to September 30, 1929, was $15,746,800, and it is anticipated that a further expenditure of $2,157,935 will be required to complete that section, making the total cost of the first section $17,904,735.

The second section to meet the increased demands anticipated in 1932 will involve an additional expenditure of $1,050,000. The third section must be in operation to meet the increase in the demand for current in 1933. It is anticipated that this section's cost will amount to $4,500,000. Thus, to meet requirements to the end of 1935, the Bunnerong power station will have cost about $22,404,735.

In addition to this expenditure on the power station there are large commitments for the distribution of the increased supply of current. Large works have also been necessary to connect the station to the distributing system, including the construction of large substations and the laying of 30,000-volt feeders from Bunnerong to these substations.

The site of the Bunnerong power house is approximately 7.1 miles from Sydney. The area of the site is 116 acres, of which 32 acres has been reclaimed from below high water mark by the use of filling excavated from the higher portion of the site. This site has been prepared for the installation of a generating plant capable of meeting demands up to 300,000 kilowatts.

There are now installed six 25,000-kw., 1,500-r.p.m. turbine-alternators. Each of the turbines exhausts into a separate surface condenser. There are eighteen 350-lb., 650-deg. boilers now installed, each capable of evaporating 100,000 lb. of steam per hour at normal rating. Coal is brought to the site by railway. Later, if it proves economical to do so, harbor works will be constructed, and the coal brought to the site by sea. The coal is delivered to the station by bottom-dump coal cars which discharge into one or other of the three underground hoppers.

From the hopper the coal falls through a crusher into an automatic skip, which discharges on to a horizontal belt conveyor delivering to any desired point in overhead bunkers. From the bunkers the coal descends by gravity into the hoppers of automatic stokers of the retort type. The ash and clinker from the grates of the stokers fall by gravity through grinders into chutes, which deliver into water-filled pits in the floor of the boiler house basement. Each of these pits is commanded by electrically operated traveling grabs running on a suspended rail. The grabs collect the ash and clinker from below the surface of the water and deliver them into one of the two hoppers in the basement. The hoppers discharge into an automatic skip hoist delivering into elevated bins, spanning the railway sidings, which discharge into the empty coal wagons.

Condenser cooling water is drawn from Botany Bay. The inlet from the bay is at Bumborah Point. This position was chosen partly to get an inlet in rock and partly because it is desirable to keep the inlet well away from the outlet, by which the warm water from the condenser re-enters the bay. From the inlet the water travels the first 1,600 ft. through two tunnels. These discharge into one common canal parallel to the outer wall of the turbine house, from which the circulating pumps draw. The water, after passing through the condensers, is discharged into the outlet canal between the inlet canal and the outer wall of the turbine house. The outlet canal conveys the water 2,200 ft. to the bay.

Electricity is generated at 11,000 volts and stepped up to 33,000 volts. At this latter voltage it is controlled in a switch house entirely isolated from the rest of the power house station buildings. In the switch house are the terminals of the 33,000-volt underground cables by which the power is transmitted to different points of the metropolitan area. The main buildings comprise boiler house, pump house, and turbine house. These are erected in steel and brick at a level of 5.5 ft. above high tide level. A separate building houses the switch gear. It is constructed of reinforced concrete at a level of 55.5 ft. above high water level.

A Practical Discussion of

HEAT INSULATION

BY EUGENE F. ZEINER
Philip Carey Company

Information that will aid in selecting the proper type of insulation for given conditions. This article, the first of a series, indicates the properties that good insulating material should possess

THE practical man who can see unburned fuel dropping through his grates knows that something should be done about it—some remedy should be employed to stop this loss. But he cannot see the heat waste from bare and improperly insulated steam pipes, boilers, ovens, chemical equipment, oil stills, and other hot surfaces, though the loss in dollars for fuel is just as surely going on.

Energy in the form of fuel is purchased and transformed through costly apparatus such as boilers, stills, etc.; labor is added to it; and steam to drive engines, turbines, and pumps is the result. The actual energy in the steam available for power production is but a small percentage of the initial input of energy, and its cost is high. All users of steam, whether of high or low pressure, recognize the necessity of hot, dry, steam, because such steam means maximum power.

"What price heat?" could be well applied to steam lines and other hot containers. The fact that the loss from 1,000 sq.ft. of exposed surface at 100 lb. steam pressure represents over 300 tons of coal annually is sufficient justification for serious consideration of ways and means to reduce this loss. Suitable insulation would save 90 per cent or more of such waste, and pay for itself in a few months. Although the waste from no insulation and under-insulation does not manifest itself by blowing a hole in the boiler house roof, it does make a serious dent in pocketbooks, and is the more dangerous, because it goes on year after year without our realizing it.

Successful businesses today produce profits. Among the factors determining profits are production costs and maintenance charges. An important item of production cost is the fuel bill. The stockholder, the executive, the engineer, as well as the coal handler is vitally concerned in minimizing the tons of coal shoveled into the furnace. The less coal fired for the same amount of product the greater the profit.

"In the good old days" when the rule-of-thumb principle prevailed many an engineer laughed at the idea of radiation losses. They "didn't amount to anything." He did not know that a pair of bare, heavy, 10-in. flanges at high pressure cost him or his firm a ton of coal a year.

A few facts regarding the early insulation days, as related by R. A. Keasbey, who is credited as being the first man to sell 85 per cent magnesia in New York City, seem to be worth while as a background against which to paint a picture of present-day material and methods.

Forty or fifty years ago almost anything seemed to be satisfactory as pipe covering. Rags or bits of carpet, clay with a binder, cut hair or cat tails mixed in a mass and troweled on pipes was the vogue. Later on, improvement came in the form of hair felt wrapped around pipes over a protection of asbestos paper and covered with canvas. Wool felt paper covered with canvas was also extensively used on steam pipes.

Practically all the materials used for pipe covering in the early days were of organic base, that is, of vegetable or animal matter, and therefore subject to decomposition at temperatures around 300 deg. In those days a steam pressure of 75 or 100 lb. was considered reasonably high. The temperatures at these pressures were considerably above the decomposition point of the materials used, and so it is little wonder that damage due to fire repeatedly occurred in plants so insulated. Investigations at the Massachusetts Institute of Technology for the fire insurance companies and factory owners in New England proved that such hazard was caused by spontaneous combustion brought about by the decomposition of the organic insulating materials.

The outstanding development and improvement in the art of pipe covering occurred with the manufacture of 85 per cent magnesia and the production of sectional pipe covering. The story of the "discovery" of 85 per cent magnesia, which came about in a peculiar manner, may be of interest. The inventor had been engaged in the pipe-covering business for many years. He was affected with stomach trouble and was advised to nibble carbonate of magnesia. He had been carrying a piece of magnesia in his vest pocket for sometime when he suddenly realized its lightness, and the thought came to him that it might make a good non-conductor of heat. He placed the block of magnesia on a hot stove. Later he picked it up and finding it still comparatively cool, remarked, "This is going to revolutionize the pipe covering business"—and it did.

Hand in hand with the development of 85 per cent magnesia came the discovery of commercially sized deposits of asbestos in Canada. The asbestos fiber re-

placed the use of chopped rope as a binder in magnesia and other forms of insulating materials, and made for covering of permanence and of high-heat insulating efficiency.

Heat leakage means money loss. A general understanding of how heat is lost from hot surfaces makes more reliable one's judgment and appreciation of insulating materials and how they function. Heat loss from uninsulated surfaces and heat transmission through insulating materials can take place only where there is a difference in temperature, the flow of heat being from the hotter to the cooler region. According to accepted ideas, there are three methods by which heat can be transmitted, by radiation, by conduction, and by convection. For example, the heat and light which reach us from the sun are given off by the sun as radiation. Again, by conduction, heat is transmitted from the hot to colder portions of a substance through the solid constituent of the substance, and without transfer of parts of the substance. With convection, however, heat is carried from place to place by circulation of the particles of matter with which the heat is associated.

There is conclusive evidence that the radiation of light and heat are similar, the waves constituting light being short, and those of heat relatively long. Also, heat radiation obeys the same laws of reflection, refraction, and

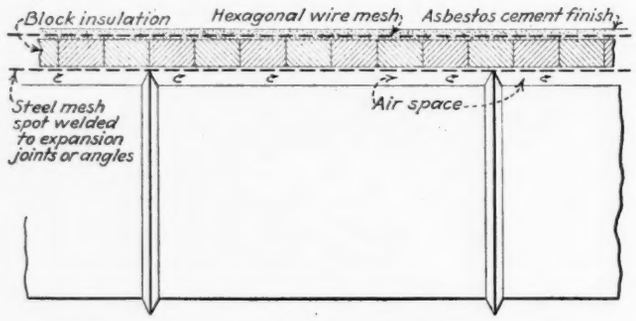


Fig. 1—Air space does not increase value of insulation, but on breechings having expansion joints or reinforcing angles it may decrease cost of application

interference as does light radiation. Thus radiations from a source of heat which fall on a body are either absorbed, reflected, or transmitted. If a body is opaque, none will be transmitted. It is obvious, then, that what is not absorbed will be reflected from the surface of the body. Therefore, a good reflector will be a poor absorber of heat. It is particularly advisable to bear in mind that heat given out in radiation is in proportion to the difference of the fourth powers of the absolute temperatures, and directly proportional to the emitting power of the hot material.

In view of the fact that conduction is transmission of heat through the particles of a material, it is desirable in an insulation to use a minimum of material and to have as little direct contact between portions of material as practicable. In this connection, the minimizing of material used in the making of an insulation has to be balanced against the important factors of strength and durability.

As mentioned above, heat is transferred by the circulation of particles of gases and fluids. To effect circulation, a difference of pressure is necessary. The ordinary heating system radiator heats the air adjacent to it by conduction. The density of this heated air is reduced, creating a difference in pressure in the air filling the room; circulation begins and heat is thus carried throughout the entire room.

In the manufacture of heat insulation, the chief concern is with means of reducing convection and conduction to negligible quantities. Heat transmission by radiation plays but a small part at temperatures experienced in the saturated steam temperature range. At the temperatures of superheated steam, of oil refinery apparatus, and in the semi-refractory field, radiation plays a more important rôle and should be taken into account in the design of practical and efficient insulation.

Of all substances practical for use in the manufacture of insulating materials, "dead" or non-circulating air offers the greatest resistance to the flow of heat. The substance of an insulation is arranged so that a great number of tiny air spaces are trapped between the fibers or crystals that make up the body of the insulation, so that convection, though it may not be entirely prevented, is greatly reduced and ceases to be important. Surface resistance, or friction, plays a large part in retarding air circulation.

In addition to embodying the maximum amount of "dead" air to assure low heat conductivity, a good heat insulation material should have low specific heat, low specific gravity to minimize the weight on piping systems, and sufficient mechanical strength to withstand vibrations and impacts. It should be capable of resisting the effects of moisture and acids; it should not crack under alternate heating and cooling, and with alternate wettings and dryings; it should not disintegrate or decompose at temperatures to which it must be exposed;

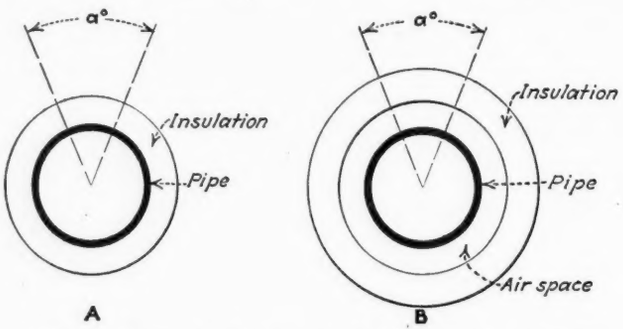


Fig. 2—Greater area of covering available for absorbing heat at inner surface, and for giving heat up at the outer surface results in greater heat loss from installation *B* than installation *A*

it should have low heat shrinkage; and it must be non-inflammable.

There is a method of insulation which has survived from the "early days" and which still retains a considerable following among engineers. It is based upon the impression that an air space between a hot surface and the covering provides effective insulation. This air space, of an inch or more in thickness, is perhaps secured by means of V-rib lath, over which is applied the insulation proper, and is of such proportions that circulation can freely take place. The circulating air carries heat from the hot surface to the inner surface of the insulation with but little drop in temperature, and therefore little actual insulation value is obtained from its use. In the superheated steam and higher temperature ranges radiation is of more importance, and an air space offers negligible resistance to the flow of radiant heat.

In May, 1921, the Mellon Institute of Industrial Research at the University of Pittsburgh conducted a series of tests to determine the value of an air space between hot surfaces and insulation. These tests were made on a

3-in. pipe, covered with 3-in. thick 85 per cent magnesia insulation over a 1.187-in. air space. Thermocouples were used to determine the temperature of the outer surface of the pipe, the inner surface of the insulation, and that of the outer surface of the insulation. The overall temperature differences used in the test ranged from 200 to 700 deg.

The conclusions reached as a result of these tests were:

1. An air space is of little value as an insulation on high-temperature surfaces, and at such high temperatures a $\frac{1}{4}$-in. space is as good as a 1-in. space.

2. Air spaces around smoke breechings are of no value as extra insulation or as a protection for the insulation against high-temperature deterioration. The main purpose of such an air space would be to allow free expansion of parts covered and to prevent cracking or damage to the insulation due to unequal expansion.

3. The temperature drop across an air space at high temperatures is comparatively small, and for practical thicknesses of insulation can be taken as approximately 30 to 40 deg.

The conclusions drawn from this test are of use in the insulation of certain classes of equipment. For instance, in the construction of certain designs of flues, breechings, hot-air ducts, heaters, etc., where expansion joints, reinforcing angles, and ribs are provided an air space facilititates the application of the insulation, as a flat, unbroken surface is obtained. The creation of an air space costs approximately 10c. per square foot, exclusive of insulation, and, in view of the fact that little added insulation or protection to the insulation is obtained, such an air space does not seem economical except where the irregularities of the surface covered make its use expedient by reason of a greater labor cost to fit the insulation into odd-shaped recesses.

The use of an air space on cylindrical surfaces is obviously uneconomical, as no added insulation is obtained and a greater quantity of insulating material and labor is required. In fact, an air space on cylindrical surfaces is often a source of increased heat loss because of the greater area available for taking up heat at the inner surface of the insulation and for giving it off to the atmosphere at the outer surface, as indicated by *A* and *B* in Fig. 2.

Filling Air Space Increases Heat Resistance

Where an air space is necessary because of mechanical peculiarities, and where heat saving is the end in view, the air space can be made effective by filling it with loose material, such as asbestos fiber or diatomaceous earth. Introduction of loose material breaks up the air space into tiny parts and largely eliminates circulation of air. Of course, a path for conduction losses is introduced, but that loss is small compared to the gain in the elimination of most of the convection loss. If such a filling is used, it should be of such type and so arranged that packing or settling will not result in large free air spaces, which, with their accompanying convection losses, would appreciably nullify the advantages to be gained by the filling. Where fillings or flexible insulating materials are used, care should be taken in their selection to insure against decomposition from high temperature and the presence of moisture.

[A future article by Mr. Zeiner will discuss the raw materials used in the manufacture of present day insulations, and their construction into the familiar forms of insulation.—Editor.]

Refrigerated Motors and Other Pipe Dreams

By Elmer S. Smail

PROBABLY never before in history has there been so much speculation with respect to new methods of power production. Reheat cycles have followed close on extraction cycles, binary vapor cycles have challenged internal-combustion methods, and of late inter-atomic energy has pushed aside even the old favorite tide motor from public interest. Distinguished engineers will now listen to proposals for utilizing heat from solar radiation, and even from the earth's interior, which if advanced ten years ago would have met with calls for the police.

We are perhaps not becoming more credulous, but are becoming more impatient. There is certainly something admirable in this "divine discontent," as it is the stuff from which progress springs, but it offers a wonderful opportunity for the charlatan to practice his trade on the unwary. It is also the source of much lost motion—mental and physical—by well-intentioned inventors who lack the fundamental scientific or business knowledge to evaluate their own ideas.

It may therefore be of interest to reivew some of the power schemes which at first sight seem to offer possibilities, but do not mean anything.

The Cold-Motor Scheme

It is a matter of common knowledge that an electric motor gets hot when in service and that, if worked too hard, it will become so hot that the insulation will be damaged and possibly the windings melted. Granted sufficient mechanical strength, there is no reason why, if you kept a 10-hp. motor cold enough, you could not get much more than 10 hp. out of it. Some of this heat is the result of friction (bearing and air), but the bulk is "copper loss" caused by the passage of the electrical current through the windings.

It is an accepted fact that the electrical resistance of most metals, including copper, increases with the temperature, which, of course, aggravates the motor situation. The change in resistance is close to one-fifth of 1 per cent for every degree Fahrenheit.

This scheme involves a refrigerating machine attached to and driven by the electric motor. The cooling coils would bear such relation to the motor elements that no temperature rise would be possible. Briefly, the harder the motor is worked, under this plan, and the greater the heat developed in its windings, the greater would be the cooling effect of the direct-connected refrigerator, so that temperature equilibrium would be the result.

An added element is that electrical resistance decreases with reduction in temperature at the rate given above. Speculate with delight on the result of cooling a motor 500 deg. F. below normal! The resistance would be zero—copper loss would be eliminated! This is really in advance of even the most sanguine promoter, but it indicates the enormous electrical possibilities which will follow improvements in refrigeration.

However, before we become overcome with delight over the vision of bell wire carrying thousands of amperes, let us see how the law of conservation of energy is going to affect the scheme. Suppose the motor had an efficiency of 70 per cent and that the copper loss was 20 per cent. This loss would represent a certain number

of watts or B.t.u.'s—say 100 B.t.u.—in some unit time. If the motor is overloaded this may increase to 200 B.t.u., and if we are going to maintain the same temperature we must carry away this extra 100 B.t.u. with the refrigerator.

Ordinarily the refrigerator efficiency will not exceed 60 per cent. Hence we must use up 167 B.t.u. of energy to keep down the temperature, and all this energy must come from the original motor. In passing through the windings it will cause additional power loss. Dodging all thermodynamics, the situation is exactly that of the man who gets overheated fanning himself to keep cool.

The Heat-Expansion Scheme

Everybody knows that metals expand with heat. A steel bar one foot long will expand 0.00007 ft. when heated 10 deg. F. If restrained, the bar will exert pressure. The amount of this pressure is roughly the tension which would stretch the bar the same amount without temperature change, and it is quite obvious that steel bars of appreciable size require considerable tension to elongate.

Suppose we take a steel shaft 100 ft. long having 20 sq.in. cross-section and alternately expose it to the direct sunlight and shade in a climate where a temperature difference of 10 deg. exists between sun and shadow. When hot the shaft will attempt to become 0.007 ft. longer, and will exert a pressure of 42,000 lb. against the restraining members. Eureka! Here we have the elements of a power plant. All we have to do is to manipulate an awning and our steel bar either pushes or pulls 42,000 lb., and if we want more power, we just add more steel bars. But before we invest let us make a further examination.

When cold the bar exerts no pressure. When it is heated the full 10 deg. the pressure is 42,000 lb. and the average pressure through the length of travel will be 21,000 lb. for the distance of 0.007 ft., making a total of 147 ft.-lb. theoretically available. Not even the most enthusiastic promotor would claim over 90 per cent efficiency in the mechanism transforming this work into useful form, and the net usable result would be 132 ft.-lb. It would take at least 10 min. to heat up the bar even in desert regions, and 132 ft.-lb. in 10 min. is 0.0004 hp. Enough to wind the clock, but not much more.

The Thermocouple Refrigerator

Science is full of examples of reversible operations. Give a motor electrical energy and it will deliver mechanical energy. Reverse the situation and you have the generator. Run a hydraulic turbine backward and you have a pump. A new "project" is to reverse the thermocouple. Briefly, a thermocouple consists of two metals, say bismuth and antimony in contact and so placed that one junction is hotter or colder than the other. Under this condition an electric current is produced, the voltage depending on the temperature difference. This is frequently made use of as a temperature-measuring device.

Now, if making one junction colder than the other produces a current, why is it unreasonable to expect that if current is supplied to such a couple, one junction will be colder than the other? This being granted, all that is necessary for a home refrigerator is a box with thermocouples in the walls. These couples must then be connected to the source of electrical current in such manner that the hot junction will be on the outside at room temperature and the inside junction will be the cold one at below room temperature. Very simple and no moving parts whatever.

The answer is that it may not be unreasonable to *expect* such a result, but the government maintains institutions for people selling stock on the basis of such expectations.

Light From Nothing

The stage sleight-of-hand performer probably was the originator of the expression "The hand is quicker than the eye." As a generalization this may be incorrect, but it is a fact that the human eye is not as fast as it might be, and we have the phenomena known as the persistence of vision. An electric light connected to an alternating-current circuit is actually without voltage twice every cycle and the only illumination it gives is from the residual heat stored in the filament from the time that peak voltage was impressed upon it. Does the lamp go out? Does it even flicker? Those who live in 60-cycle districts will answer "no," but keen-eyed ones in 25- and 30-cycle territories will report a flicker.

Actually the light flickers on all frequencies, but the eye is too slow to detect the darkened periods when they are on the order of 0.01 sec. A marvelous scheme for making use of this human disability is the rotating chandelier. Here we use, say, four 16-candlepower lamps on arms perhaps two feet long radiating from a rotatable center.

When the chandelier is stationary we have only four 16-candlepower lamps. When rotated at a high speed, these lamps, to our crude eyesight, seem to merge and we have the appearance of a circle of light equivalent to much more than 64 candlepower. Or don't we? Stock was actually sold in this scheme some time ago.

Relation of Dew Point to Relative Humidity

A PECULIAR RELATIONSHIP between the dew point and the relative humidity found useful in air-conditioning work is that for a fixed relative humidity there is substantially a constant difference between the dew point and the dry-bulb temperature over a considerable temperature range. The following table giving the room temperature, dew-point temperature, and dew-point differentials for 50 per cent relative humidity illustrates this relationship most clearly:

Dry-bulb temperature (deg.)	65	70	75	80	85	90
Dew-point temperature	45.8	50.5	55.25	59.75	64.25	68.75
Difference between dew point and dry-bulb temperature	19.2	19.5	19.75	20.25	20.75	21.25

It will be seen from an inspection of this table that the difference between the dew-point temperature and the room temperature is approximately 20 deg. throughout this range of dry-bulb temperatures, or, to be more exact, the differential increases only 10 per cent for a range of practically 25 deg.

This principle holds true for other humidities and is due to the fact that the pressure of the water vapor practically doubles for every 20 deg. through this range.

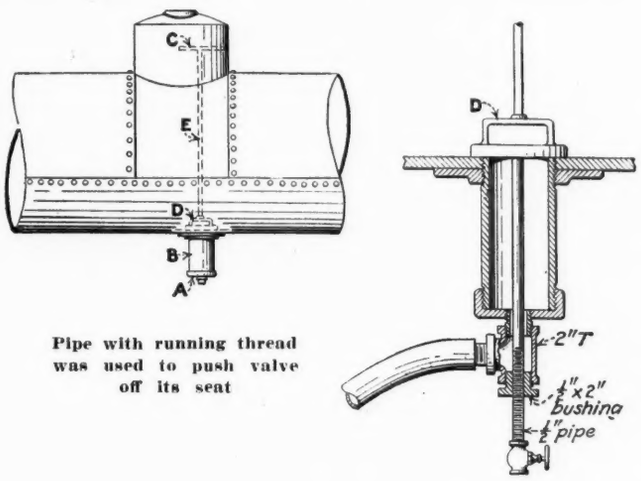
This principle is useful in determining the available cooling effect obtainable by the use of ventilation with saturated air when a desired relative humidity is to be maintained in a room even though there may be a wide variation in room temperature.

. . . RIGHT OUT OF THE PLANT . . .

How Oil Tank Car Valve Was Opened in an Emergency

SOME TIME AGO we received a car of fuel oil in which the operating rod had become disengaged from the valve at the bottom of the car. It was therefore impossible to open the valve in the usual way.

With normal conditions, when cap *A* is removed, the unloading hose is attached to part *B*. Then the valve



Pipe with running thread was used to push valve off its seat

is opened by turning handle *C*, which, in turn, lifts valve *D* off its seat, allowing the liquid to run out.

Rather than pump the contents of the car out of the top, we made up the following attachment to push the valve off its seat. Cap *A* had a 2-in. plug in the bottom. This was removed and a 2-in. close nipple and tee were screwed in as shown. After fastening the unloading hose to the side outlet of the tee, a bushing was tapped to take a ½-in. pipe having a running thread. The pipe and bushing were screwed in place, and a ½-in. valve was put on the lower end of the pipe. When everything was ready the pipe was screwed upward and the valve pushed off its seat.

GEORGE G. AVANT.

Charlotte, N. C.

The Foreign Machinery Complex

REFERRING to the editorial of Aug. 19, "The Foreign Machinery Complex," our ex-President came near to scoring in the inner ring. It was a needed and well-intentioned shot, but he doesn't seem to have caught clearly the number of the target to be shot at. There appears to have been a mix-up somewhere. What was intended by a naval officer as a specific criticism has apparently been taken by the lay mind as a generality.

Unless my source of information is in error, the original criticism was to the effect that none of our manufacturers has made a sincere effort to produce a highly satisfactory airship engine. This is not necessarily the same as referring to an aviation engine. The latter term frequently, because of the relative numbers in existence, refers to an airplane engine. Should evidence of the quality of our airplane engines be desired, there is the recent case of the Germans putting our engines on their large DO-X airplane intended for trans-Atlantic flight.

Your comment concerning corporations adopting foreign engine designs in place of designs originating at home could well be extended. The situation is far-reaching, more so than commonly visioned. Twenty-five years hence, when Europe has thoroughly absorbed both our methods and our machines of production, the seriousness of our present procedure will be well appreciated.

Mass production in education tends to mass thinking and suppression of the capacity to criticize. But a pioneer idea—and we pride ourselves on our originality—is the product not of mass minds but of the individual mind. Hence already, although we are strong and leading commercially, we are weakening, in comparison with Europe, on individual thinking. Finance shouts, "How do you make it?" An article salable today is considered more valuable than the foundations of ten ideas available for tomorrow's developments. The *why* interests finance little, and hence original designs will tend to come from those countries that may have less money but more pioneer thinkers.

One of our greatest claims is possession of inventive ability. Expression of such ability usually springs from an incentive, commonly money. But what are the incentives now being provided by our great laboratories? One of the largest frankly is opposed to "conspicuous rewards" for inventions of its employees, giving rather just a little salary boost—not too large, for fear, so the excuse is given, of creating envy among the staff.

We have, first, production of mass thinking through mass production in education, and a resulting absence of criticism such as is desirable in the plans of some of our one-track minds. Then we have discouragement of invention by deliberate reduction of incentive. Then further cramping of the scope of new developments by emphasis on production costs and increase of mergers. Finally, importation of foreign designs.

Furthermore, because the rewards for ingenuity and learning are decreasing, the American-born is looking for money in other fields, in sales and kindred branches. Entry of the foreign engineer to do our engineering will probably be the outcome. The question is, "Whither American ingenuity?"

ROBERTSON MATTHEWS.

Detroit, Mich.

The Utilization of Sulphite Wastes in Pulverized-Coal Firing

EARLY this year there was an article in *Power* on the power plant of the Gulf States Paper Corporation at Tuscaloosa, Ala. At this plant liquor returned from the paper mill is burned under the boilers. The following is a description of a method for preparing and burning sulphite wastes of paper mills as pulverized fuel.

Even since their early beginning paper mills have disposed of their sulphite wastes by discharging them into the adjacent river. Much of the organic matter contained in these wastes decomposes and pollutes the river water, which often seriously injures the rights of downstream property owners.

Raw sulphite wastes, even when considerably thickened, are difficult to burn and usually yield less than 3,600 B.t.u. per pound. However, if the material is dried before burning it may yield as high as 9,000 B.t.u. per pound, which suggests that its successful application as a fuel depends upon cheap drying and a practical firing method.

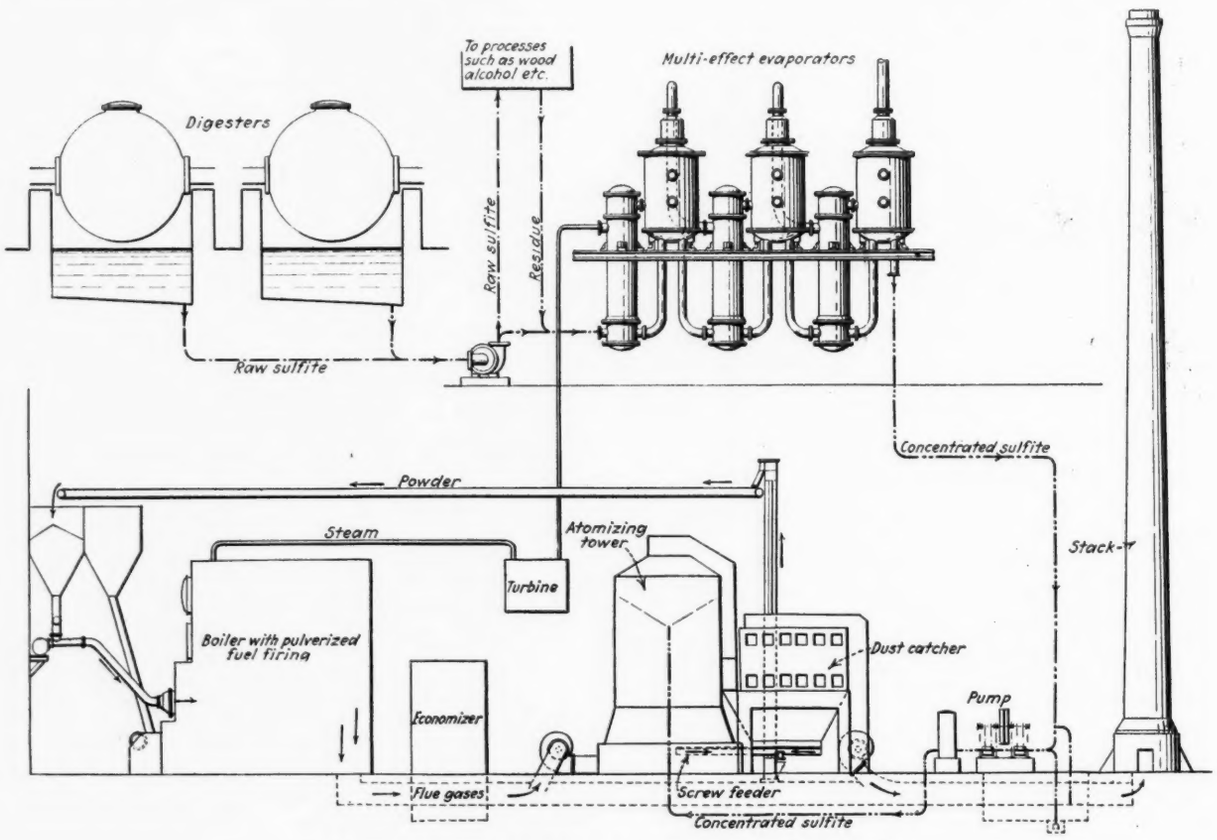
A system which I have developed for drying, pulverizing, and burning sulphite wastes is shown schematically in the accompanying illustration.

The raw sulphite, containing between 88 and 90 per cent of water, is passed through multi-effect evaporators, which reduce the water content under a partial vacuum to between 50 and 60 per cent. The partly dewatered material enters an atomizing drier, which reduces the moisture content to between 5 and 8 per cent, by means of heat obtained from the boiler flue gases. Hot gases are delivered past adjustable dampers and baffles into a drying tower, into which the thickened sulphite wastes from the evaporators are sprayed through an atomizing nozzle. The fineness of the atomization is controlled by a pressure-regulating valve in the pump discharge.

The finely divided particles are brought into direct contact with the gases, and they dry, almost instantly, to fine powder, which falls to the bottom of the tower and is conveyed by a screw feeder to the burners. The saturated gases pass through a dust catcher, which recovers the entrained dust and delivers it into the bottom of the tower. A fan maintains an induced draft through the tower and compensates for the draft resistance. It is also feasible to include a forced-draft fan. The entire drying equipment may be cut out of service when desired without interfering with the continued operation of the boilers with other fuel.

As a practical example, assume a paper mill manufacturing 5,510 tons a year, which will produce 55,100 tons of sulphite waste, or approximately 7.7 tons an hour. The evaporators reduce this to 3,704 lb., which, in turn, will yield 2,017 lb. of dry powder. The latter has an average heating value of 8,100 B.t.u. per pound, and may be burned like pulverized coal under the boilers.

Exhaust steam for the evaporators is obtained from the main turbines, pumps, etc. The turbines receive steam at 135 lb. abs. If the boilers fired by the pulverized dried wastes evaporate $6\frac{1}{2}$ lb. of water per pound of fuel, 13,129 lb. of steam is generated per hour. As 3,800 lb. is required by the evaporators, there would still be 9,329 lb. of steam per hour available for generating power, which amount would greatly reduce the coal requirements of the mill.



Schematic layout of the system for burning sulphite wastes

In conclusion, it might be mentioned that the proposed system functions automatically and continuously. Only one or two attendants are necessary. It solves the disposal problem of large quantities of waste material and does not itself produce objectional waste products. As the material can usually be burned under the boiler in the mill which produces it, marketing and sales expense are not involved.

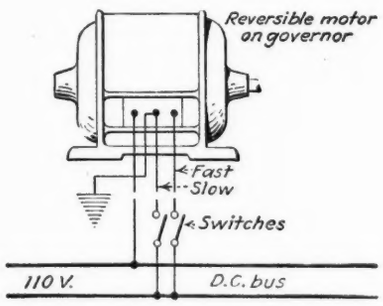
W. KUHLES,
Consulting Engineer.

Remscheid, Germany.

Ground on Governor Motor Circuit Cause Unit to Drop Load

RECENTLY one of our hydro units dropped all of its load, and as the other unit was nearly loaded the voltage and frequency dropped considerably.

The flume was full of water. The governor seemed to be all right, but the turbine gates were closed. When the knurled speed nut was turned to "fast" and released it would turn back and slow the unit down. After



Wiring diagram showing location of grounds on motor circuit

getting the unit under hand control and service at normal, a check was made of the motor circuit. A ground was found at two places, one on the collector ring and one in the motor.

The speed-control switch was wired with the common wire connected directly to the exciter bus, and in this way acted as two single-pole switches, one energizing the fast series motor circuit and the other the slow circuit.

E. SWAN.

Kearney, Neb.

Modern Questions for Power Plant Engineers

WE HAVE modern plants—the best that money can buy. Everything is up to the minute, for the purpose of maximum production at minimum cost.

The chief executives of several plants have said, "Yes, and in spite of all the money we have spent for fine machinery, our engineer's examination questions in the State of Ohio would appear to be behind the times."

Personally I believe this is true, because I have had occasion to pass examinations in New York and another state, and to secure the first-class grade or chief engineer's unlimited license I found it necessary to not only review the usual questions used in Ohio, but also to cover the entire field of steam and mechanical engineering.

Therefore I believe it would be in order for engineers and executives to give us an idea of what they consider modern, up-to-the minute questions for high-pressure pulverized-coal-burning power plants.

As a starter I offer the following:

Q.—Before lighting the fire on a powdered-coal-burning boiler what are the most important things to investigate; name in the order of their importance and sequence of operations. A.—(*a*) Blow down water column and make sure that there is two inches of water in the glass and no more; (*b*) Make sure that dampers and automatic combustion control are set for manual operation; (*c*) make sure that stack damper is wide open; (*d*) never watch the burner or open any doors in the furnace while fire is being lighted.

Q.—If the flame blows out on a pulverized-coal burner what would you do first? A.—Shut off the pulverizer or coal feed and open the damper on manual control.

Q.—If the burner blows out and fills the furnace and tube banks with unburned powdered coal tell how you would proceed to relight the burner? A.—Never relight the burner without blowing out the furnace with all secondary-air and stack damper wide open. Some men consider it advisable to blow the tubes with soot blowers in bad cases.

Q.—How often do you consider it advisable to blow down water-cooled side walls? A.—Originally the boiler manufacturers told us not to blow them down with burners lighted and load on the boiler. However, our experience in one plant proved that this could not apply in all cases, because the bottom header became plugged with sludge and resulted in blowing out a tube. Therefore, some plants do blow their tubes while burners are lighted, but they blow them down when the load is light. Where all of the water supplied to the boiler is condensate and the make-up is supplied from evaporators, it is not necessary to blow down side walls.

Q.—If a feed pump should lose its prime and you could not regain it what would you do, assuming that you have no other pump to fall back on? A.—Put the fire out immediately before you lose the water. Then, assuming you have water in sight, pull the pressure down until the emergency water supply, city water, etc., will enter the boiler. Make sure the feed pump is pumping before relighting the fire.

Q.—What do you consider the most important thing to do before starting a steam turbine? A.—Make sure that all drains are open wide. Preferably into the atmosphere.

Q.—If you have an extraction turbine with non-return valves on the extraction line, and the turbine starts to overspeed, but the overspeed safety governor does not function, what is the first thing you should do? A.—Trip emergency by hand and kill the vacuum by shutting off the gland seals and air jets or vacuum pump.

Q.—Would you shut down the circulating pump (in the previous question)? A.—No, not immediately, because the steam may be backing up from the extraction line. However, if the condensate pump stops, the circulating pump should be shut down before the condenser fills up with condensate. There should be a drain to the atmosphere for such emergencies and also for use when the turbine is down. I should act as follows: (*a*) Trip out the turbine; (*b*) close the valves supplying steam to seal both ends; (*c*) shut down dry-vacuum pump; (*d*) let circulating pump run; (*e*) open condensate drain to atmosphere.

WALDO WEAVER.

Chillicothe, Ohio.

From Among Readers' Problems

Conducted by
L. H. MORRISON

SETTING SAFETY VALVE FOR REDUCED PRESSURE—*In my heating plant I have two 56-in. x 16-ft. return-tubular boilers. The safety valves are set at 125 lb., and it is desired to reduce the pressure to 100 lb. The insurance inspector says that there is no need of changing the springs; just set them. Will they work all right? Could they cause any damage to the boilers?* W.A.D.

A safety valve should be of sufficient size and have enough lift to discharge all the steam that could be generated at the safe working pressure for the boiler. The lower the pressure of steam to be discharged the less the density and the larger the valve opening required for discharging the same weight of steam in a given time. Undoubtedly, the inspector has decided that the discharge capacity of the safety valves would be sufficient under the conditions, and it is not likely that in following his suggestions any damage would result to the boilers.

SUBMERGED PISTON AND STRAIGHTWAY PUMPS—*What is the difference between a submerged piston pump and a straightway pump?* J.T.H.

Submerged piston pumps are like the ordinary direct-acting duplex steam pumps with both the suction and discharge valves above the water pistons; in the straightway pattern the suction valves are below and the discharge valves are above the water pistons, so the passage of the water through the pump is more nearly continuous than in the submerged piston type.

PITTING OF FIRE TUBES OF HEATING BOILERS—*Several of our school buildings that are warmed by a vacuum system of steam heating are equipped with boilers having 3-in. fire tubes. The tubes become pitted through and need to be renewed after two or three heating seasons, whereas the same make and size of tubes used with the same feed water last about five times as long in fire-tube boilers of neighboring factories. Why should there be so much difference in durability of the tubes?* P.J.C.

General boiler corrosion of the heating boilers may be more rapid from infiltration of air through leaky supply or air valves or from conditions more favorable to electrolysis induced by stray electric currents. It is also likely that the boilers are not well protected from corrosion during summer seasons. When laying up boilers the old water should be drawn off. When the boilers are dried they should be closed up tightly after placing in them liberal quantities of unslacked line; or, after being washed out, the boilers should be laid up filled to the top with fresh water containing barely enough lime to make a thin lime wash.

It would be worth while to try these precautions.

A Question for Our Readers

WE HAVE a 200-ft. smoke stack, stack and breeching designed to ultimately serve six 4,000-sq.ft. boilers having underfeed stokers and forced draft. With only two boilers in service we have 1¼-in. chimney draft. This carries a large amount of fly ash out of the stack, causing complaints from residents in the neighborhood. We operate with dampers nearly closed, as we need only 0.1 to 0.2 in. draft over the fire.

Can this fly ash be prevented from going out of the stack? Could it be made to collect in the base of the stack by opening the end of the breeching, to admit enough air to reduce the stack draft to about 0.5 in.? Would it be necessary to install a damper in the stack above the breeching entrance to cause the fly ash to be deposited in the base? J.J.H.

Suitable answers from readers will be paid for and published in the Oct. 21 number

NAVY BOILER COMPOUND—*What is navy boiler compound?* F.A.

The navy has issued a standard specification for boiler compound composed of sodium carbonate (76 per cent, anhydrous, Na_2CO_3); trisodium phosphate (10 per cent, $Na_2PO_4 12H_2O$); starch (1 per cent); and sufficient cutch or dry extract of hemlock, oak, or chestnut bark (not dry extract of quebracho) to yield 2 per cent of tannic acid—the remainder to be "water and only such impurities as are common to the ingredients"—; the materials to be intimately mixed and finely powdered.

TRANSFORMERS IN PARALLEL—*We have one 75-kva. lighting transformer that is overloaded and another rated at 37½ kva. that is underloaded. Is it possible to operate these two transformers in parallel on the secondary side and divide the load between the two transformers in proportion to their capacities?* J.M.

The two transformers may be operated in parallel, but it may require some changes in the resistance of the leads, between the transformers and the point where they connect in parallel. Apparently, when the two transformers are connected in parallel they will be loaded very nearly to their rated capacity, and it might require some nice adjustment of the lead's resistance to prevent one or the other of the transformers from being overloaded. If this proves difficult it may be better to operate each transformer as a separate unit and take some of the load off the large unit and connect it to the small transformer. The latter will be the more simple method of getting the proper load division.

TEMPERATURE-COLORED PAINT—*Is it possible to paint piping so that the color changes to show if the pipe is hot or cold?* A.M.

It is easy to make up a paint that changes color with temperature.

A common method is to make up double iodides of copper and mercury or of silver and mercury, and mix the dry powder with spirit varnish. This sounds complicated, but is really very easy.

The copper-mercury iodide is bright red at ordinary temperatures, changes to a dark chocolate brown at 160 to 175 deg. F., and to almost black at 212 deg. F., and becomes bright red again on cooling. The pigment is made by mixing 1 part by weight of cuprous iodide with 2 parts of mercuric iodide.

The silver-mercury iodide is made by mixing 5 parts of silver iodide with 1

part of mercuric iodide. When these are first mixed the color will be red, but it will gradually change to yellow as the mixing proceeds. The shade of color, indicating cold and hot, can be varied by changing the proportions of the ingredients. With a 5-to-1 ratio the cold color should be a light yellow, changing with temperature to orange. With more mercuric iodide the cold color will be a darker yellow or orange, and the hot color a brick red, at 150 to 175 deg. F.

The iodides required for these mixtures can be purchased from drug supply houses or can be made from materials available in any drug store. Mercuric iodide may be made from mercuric chloride (corrosive sublimate) and potassium iodide, cuprous iodide from copper sulphate and potassium iodide, and silver iodide from silver nitrate and potassium iodide.

The dry powdered mixtures should be mixed with a thin, light-colored, non-acid oil or spirit varnish, and applied with a brush. Metals such as tinned iron or brass may be painted with one or more coats. The paints cannot be used on aluminum, since there is a reaction with the metal that destroys the paint.

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CHANGED RATIO ON METER TRANSFORMER—*In our plant we have a 3-phase wattmeter with the following data given on it: 5 amperes; 110 volts; current transformers, 20:1; potential transformers, 20:1. The two current transformers connected to this meter have a ratio of 25:1, and the potential transformers have a ratio of 20:1. What effect will the change in the current transformer have on the meter's reading?* M.O.B.

Assuming the meter is calibrated to read directly the power transmitted in the line, the change in the current-transformers' ratio will cause the meter to read low in the ratio of 25:20. To determine the power transmitted in the line from the meter, multiply its reading by the constant $25 \div 20 = 1.25$. For example, if the meter indicated 650 kw. the true power would be $650 \times 1.25 = 812.5$ kilowatts.

You should make sure that the meter has not been calibrated to the transformers to which it is now connected. If there are a voltmeter, a power-factor meter and ammeters on the switchboard the wattmeter may be checked, by taking a simultaneous reading of the meters. Then the kilowatt may be calculated from the formula $Kw. = \frac{E \times I \times PF. \times 1.732}{1{,}000}$. Assume the voltmeter reading E to be 2,200 volts, the ammeter readings I on the three phases to be balanced, and each 200, and the power-factor meter, $P.F.$, indicates 0.80. Then the kilowatts is $Kw. = \frac{2{,}200 \times 200 \times 0.80 \times 1.732}{1{,}000} = 610$. If all meters are correct the value 610 should be the wattmeter reading.

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

AT WHAT RATING is one justified in adding a water wall to a 5,000-sq.ft. boiler? We are resetting two such boilers and our consulting engineer recommends the addition of the walls, although we have never had serious refractory trouble. C.F.P.

WATER WALLS were developed to cut refractory expenses. Above 250 per cent rating with customary draft and fuel conditions, there will be a sharp increase in refractory expense.

Reduction in furnace maintenance with water walls on sides and rear may be estimated at 50 per cent. If the amount saved will amortize the water-wall investment in a reasonable time, pay the interest, and show worth-while savings, they are justified.

Water walls of proper design for circulation, refractory life, and furnace temperature will give little trouble when kept free of scale deposits. They add a certain amount of equivalent heating surface to the boiler. L. G. BIRD.

Chicago, Ill.

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DECISION regarding the use of a water wall in conjunction with a boiler installation depends more on the type of fuel burned and the kind of apparatus used to fire it than upon the boiler. In practically no case, however, is a water wall justified except for an underfeed stoker or for pulverized fuel. With chain grates it is often advisable to construct the arches with water walls faced with a refractory material, but as no mention was made of arches, it is assumed that this question deals with either an underfeed stoker or pulverized fuel.

For a good stoker installation, which means about a 12-ft. setting height for a horizontal water-tube boiler or 8 ft. to the center line of the mud drum for a Stirling type boiler, it is seldom worth while to install water walls for ratings under 250 per cent. If continuous operation is required at ratings above this amount, water walls may be justified.

With grades of coal having low ash fusion temperature water walls may be justified for the face of bridge walls for ratings over 150 per cent. With average quality Pittsburgh coal there should be little necessity up to 200 per cent rating, but at over 200 per cent rating water walls may be justified. For the side walls it is seldom that water walls will show a sufficient saving in maintenance to justify them unless it is necessary to operate continuously at 250 per cent rating or over.

For pulverized fuel installations the volume of the furnace is the controlling factor on the rating at which it is possible to operate without serious injury to the refractories. If the furnace volume for a 5,000-sq.ft. boiler is about 2,500 cu.ft., a continuous rating of 200 per cent is possible. If the furnace volume is about 3,000 cu.ft., a continuous rating of 240 per cent would not be excessive for a refractory wall providing it is of the air-cooled type. For a rating of 300 per cent it would be necessary to have a furnace volume of 3,800 cu.ft. in order to use a refractory furnace without injury to the material. In any case where the furnace volume is necessarily smaller than that required for the rating as stated, it is desirable to give serious consideration to the installation of water walls.

HAROLD LUTHER SMITH,
Consulting Engineer.
Buffalo, N. Y.

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FUNDAMENTALLY, water walls are installed to reduce steam costs. The direct purpose may be the protection of refractories, or the elimination of slag and clinker, with increased capacity and efficiency.

Water walls do not increase efficiency because of extra heat-absorption surface but rather because of the ability to permit the boiler to obtain high capacities with less excess air and lowered maintenance or operating costs. They may permit use of cheaper coal.

Therefore water walls are justified at that rating where the reduction in maintenance and operating costs gives them an economic advantage.

R. S. LANE.
Pocahontas Fuel Co., Inc.
New York City.

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OPERATING experience has shown that the use of water-cooled walls has considerable influence on stoker maintenance. Water cooling of the rear or bridge wall is particularly advantageous, owing to its cooling effect on the lower end of the stoker. Where clinker grinders are used, water cooling of the bridge wall is essential and certain stoker manufacturers insist that this be done where their equipment is installed. Definite statements or recommendation cannot be made without more details of the installation involved and the rating at which the unit is to operate. In any event, if a limited amount of water-cooling surface is added it should be placed in the rear wall of the furnace. C. ALLIS.

New York City.

Comparing Advantages of Reciprocating Steam Engine and Turbine

AS RECENTLY as 1900 the reciprocating steam engine was the only engine available to industry for the generation of mechanical or electrical energy that could be regarded as safe in operation. Since then, however, it has had to put up with a good deal of competition, more especially on the part of the turbine. The engineer frequently finds himself confronted with the question as to the kind of engine he ought to give preference.

The reciprocating engine is undoubtedly more robust than the turbine, and is sure to perform good work even if its attendance is not so efficient as it should be. The principle of its working is simpler, and, therefore, easier to understand. It may be said to deserve preference wherever working conditions are particularly difficult or wherever the safety of human life depends on the choice of engine. Its insensibility to less efficient attendance makes it suitable for use in those countries in which trained and experienced operators are unavailable. In the event of a partial or even a total breakdown the simplest kind of repair shops are capable of remedying its cause. This, no doubt, is an exceedingly valuable factor in so far as outlying districts are concerned.

In the majority of instances there is no difficulty in changing over to a system of exhaust-steam utilization with its attendant economies. The introduction of the reciprocating engine into plants with exhaust-steam utilization was long handicapped by the difficulty of extracting the lubricating oil from the exhaust steam. But this difficulty has been considerably reduced.

The economy of the reciprocating engine on the one hand and the turbine on the other largely depends on whether condensing or back-pressure operation is used. Assuming condensing operation and that the gage pressure of the live steam ranges between 171 and 227 lb. per square inch, the limit of the remunerativeness of the reciprocating engine may be said to be reached for an output of about 500 kw., because if that limit is exceeded the specific steam consumption of the turbine is more favorable owing to the better utilization of high vacuum.

In back-pressure operation the respective remunerativeness of the turbine or the reciprocating engine mainly depends on the volume of the steam passing. It changes, therefore, with the initial pressure. On the other hand, the back pressure, which normally lies between 28.4 and 56.8 lb. per square inch and rarely rises to 171 to 213 lb. per square inch, is not of much influence. Assuming an average back pressure and an average price of fuel, the following amounts of steam may be set down as the limits beyond which the turbine is undoubtedly superior to the reciprocating engine from the point of view of remunerativeness:

Initial Pressure, Lb. Per Sq.In.	Tons Per Hour
284	20
355	30
852	40
1422	50

These figures are based on the present state of development of the two kinds of engines, and give only an approximate idea of the actual conditions. Whereas the working pressures are fixed by the equilibrium between the amount of available exhaust steam and the amount consumed, it must be borne in mind that the reciprocating engine is superior as regards steam consumption if the quantity of steam is less than stated above. On the other hand, the cost of turbine units, including the cost of the foundation, is less than that of an engine with a generator coupled to it direct. Preference will often be accorded to turbines because they require less space.

To sum up, it may be said that the reciprocating engine—despite the occasional rumors as to its being antiquated—is still entitled to claim "a place in the sun."

[1]This article, abstracted from the *Borsig Technical Review*, is particularly significant as this concern manufactures turbines and reciprocating engines.

Generator in English Station Operates at 33,000 to 36,000 Volts

IN THIS country there has been built several large alternating-current generators for 22,000 volts, and others are under construction. Notable among those in operation are the three in the State Line station, near Chicago, which are connected to a triple cross-compound turbine and have an aggregate capacity of 208,000 kw. This voltage has been exceeded by over 50 per cent in a 25,000-kw., 3,000-r.p.m. generator in the New Brimsdown station of the North Metropolitan Electric Power Supply Company, England. According to London *Engineering*, this station had originally installed in it two units, each designed for 11,000 volts. One of these generators has been rebuilt by the manufacturers, C. A. Parsons & Company, Ltd., for 33,000 to 36,000 volts. It is also reported that other manufacturers in Europe are developing generators for 33,000 volts.

The Brimsdown generator was proportioned to fit on the bedplate of the 11,000-volt generator it replaced. Because of its high voltage it was considered advisable to increase the space for the end windings. As the over-all length had to be the same as that of the original machine, the effective length of the rotor had to be reduced, and to compensate for this, the rotor's diameter was increased. This required reducing the depth of the stator core and increasing the magnetic density in its outer diameter, which resulted in a somewhat greater magnetic leakage. As a result, the efficiency of the high-voltage generator is over ½ per cent less than what it would be if there were no restrictions on the design. Since there are no step-up transformers used with this generator, its losses are less than those of the normal-voltage machine and its transformers.

The conductors in the windings of the new machine are grouped concentrically and are insulated with micanite. Each group consists of an insulated center conductor. Over this one's insulation is a second insulated conductor, over which is a third. Of the three conductors, the inner one has the highest potential, and the outer one the lowest. Maximum potential between any two of the three conductors forming a concentric group is about 7,000 volts, and the maximum voltage gradient is about three-quarters of that in the normal-voltage machine.

In each phase there are 88 conductors distributed over 15 slots per pole. Starting from the neutral point the outer winding passes in succession through every one of the 15 slots. It is then connected to the middle conductors and completes the same circuit, and then connects to the center conductors of the concentric groups. The concentric groups at the beginning and ending of each phase have only two conductors, which accounts for 88 conductors in 15 slots.

Provisions have been made for varying the generator's voltage from 33,000 to 36,000 volts by adjusting the field current. The machine has been in operation for one year and nine months and has given satisfactory service even when subjected to the effects of the heavy short-circuits on the distribution system.

Illinois Mines Lead Nation in Supplying Coal for Power Plants

MINES in the Illinois coal field furnish more fuel for the generation of electricity than do mines in any other field in the country, according to a report by the United States Geological Survey in co-operation with the Institute of Economics of the Brookings Institution.

The report shows that in 1928 electric power plants burned 5,903,704 tons of coal from Illinois mines. This quantity is equivalent to 96 per cent of the coal used in the production of electricity in Illinois in the year.

Commenting on the importance of an adequate supply of water for condensing purposes in steam generating stations, the government report says that in 1928 60 per cent of the coal was consumed in stations located either on Atlantic tidewater, on the Great Lakes or on six large rivers.

WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Hydro-Vacuum System for Handling Fly Ash and Sifting

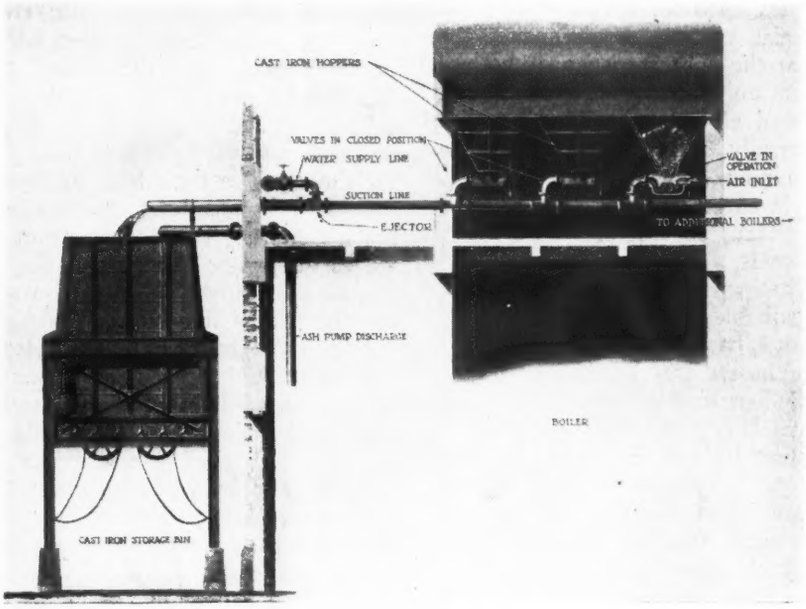
TO PROVIDE a dustless method of removing and disposing of fly ash and siftings from the last pass of boiler settings, economizers, air heaters, dust collectors, etc., the "Hydrovac" system illustrated has been developed by Allen-Sherman-Hoff Company, Philadelphia, Pa.

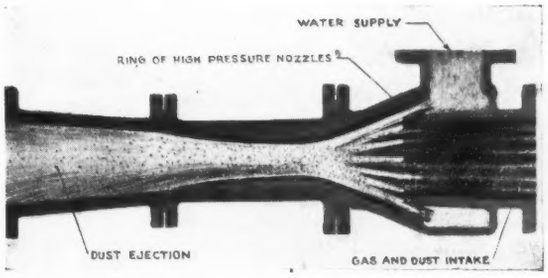
Dust and soot are removed in a dry condition through an air-swept valve bolted to the bottom of the dust-collection hopper, the dust being thoroughly mixed with water and discharged by means of a "Hydrovactor," or ejector. In the valve, which is shown in section in the lower view, ports are located on each side, one being connected to the suction line of the ejector and the other serving as an air inlet. Both ports are sealed against air infiltration when the valve is not in operation. When dust is to be removed the valve is turned 90 deg. by the operating lever, shown at the air inlet end.

Vacuum necessary to draw the air through the valve and entrain the siftings is produced by the ejector shown in the center view. The unit consists of a ring of water nozzles fed from a circular header. High-velocity water streams from these nozzles converge in the throat, entraining the dust-laden air and producing a vacuum in the suction line between the ejector and the valve. After leaving the ejector the dust-laden water is piped to point of disposal. In the typical installation shown in the upper view the ejector discharge is piped to the regular ash-storage bin.

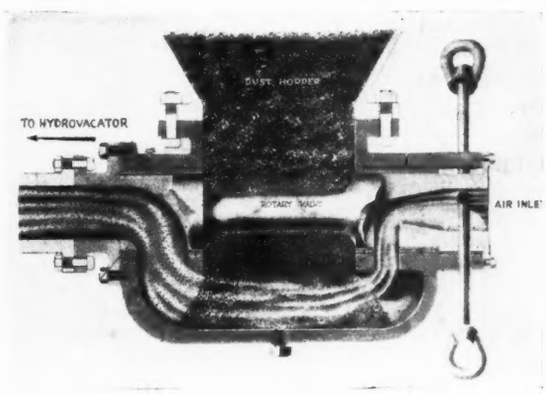
Among the claims made for this system are: It is dust- and water-tight, assuring cleanliness in operation; ejector can be installed in any position and will elevate the dust-laden air as required for disposal into an overhead bin, thus simplifying its installation in existing plants; operation is entirely automatic. Also it is impossible to overload or dam the system, since the vacuum produced in the air-swept valve is directly proportional to the quantity and velocity of the water in the ejector.

An important advantage of conveying dust to disposal mixed with water, as is done with this system, is that after the water drains off, the dust is sufficiently wetted down to prevent its blowing away.



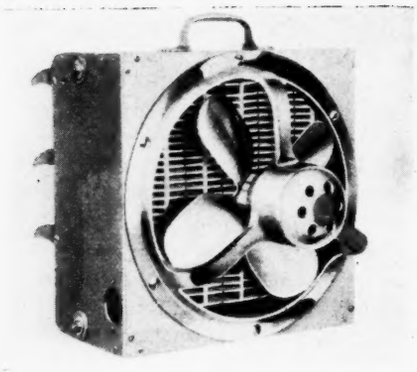


Above—Typical installation of Hydro-vac fly ash and siftings removal system



Above — Hydraulic ejector for producing vacuum and discharging siftings to point of disposal

Left — Section of air-swept rotary valve



Heater combines characteristics of both steam unit and electric heater

Electric Unit Heater

THE UNIT HEATER illustrated, designed for industrial and commercial heating requirements, combines the characteristics of both the steam unit heater and electric heater. Special alloy heating strips are cast integrally with composite fins of aluminum alloy, making up into a single smooth casting that allows an uninterrupted flow of air through its channels.

Castings of this type are assembled in suitable number and size into a cabinet, back of which a fan operates. The heater can be permanently installed or used as a portable heating unit. It is particularly applicable for heating isolated buildings, for intermittent heating needs, and for "off-season" heating. It is put out by the American Foundry Equipment Company, Mishawaka, Ind.

Continuous Blowdown Heat Reclaimer System

TO MAINTAIN boiler water at proper concentration by frequent blowing down, while conserving the heat in the escaping water, is a problem that requires attention in efficient power plant operation. A late development in this field is the continuous blowdown heat reclaimer system brought out by the National Aluminate Corporation, Chicago, Ill. In it the blowdown water is regulated to pass through a heat reclaimer system where the cold make-up water takes up practically all of the available heat. Three types of installations have been designed to meet existing plant conditions, known as the flash type and the single-stage and two-stage types.

In the flash type the blowdown water passes into a low-pressure flash chamber located at the uper end of a vertical heat reclaimer. Here a portion of the blowdown water passes into vapor and may be used for low-pressure heating or be returned to the feed-water heater or low-pressure system as pure vapor. As shown in Fig. 1, the flash chamber is equipped with a water level control which automatically operates a discharge regulator that permits the relatively cold blowdown water at the bottom of the heat reclaimer to escape to the sewer.

The heat reclaimer is practically identical in construction with a closed feed-water heater in which a special floating head is used to take care of the expansion incident to wide changes in temperature. The shell is of welded construction. Tubes are straight, and the tube nest may be removed by lifting the outer shell from its base. Make-up feed water passes through the tubes, and the blowdown water circulates outside the tubes, with baffles to properly direct its passage toward the bottom of the reclaimer. The flash type of equipment is recommended for plants having a deficiency of exhaust steam or where the heater temperature cannot be maintained over 200 deg. F. without the use of live steam.

Where the supply of exhaust steam is plentiful, the single-stage reclaimer is employed. It is of high-pressure construction similar to that in Fig. 1 (except that the flash chamber is omitted) and is installed between the feed-water heater and the boiler, where it serves as an economizer.

The two-stage system consists of two heat-exchange units without flash chambers. It is used where exhaust steam is deficient about one-half of the time. With this installation the advantages of the single-stage reclaimer are maintained and in addition the temperature of the feed water going to the heater is increased several degrees. The first- and second-stage units are similar in construction and usually are interchangeable. If desired either stage may be operated independently of the other.

Fig. 2 shows the layout of the two-stage installation. In the type of boiler shown, blowdown water is drawn from the steam drum just below the surface of the water, the amount being regulated by a variable orifice control at the side of the boiler. From the control the water flows through the first exchanger and out through the quantity control to the second-stage heat exchanger, from which it passes through a quantity control valve to the sewer. These quantity regulators maintain

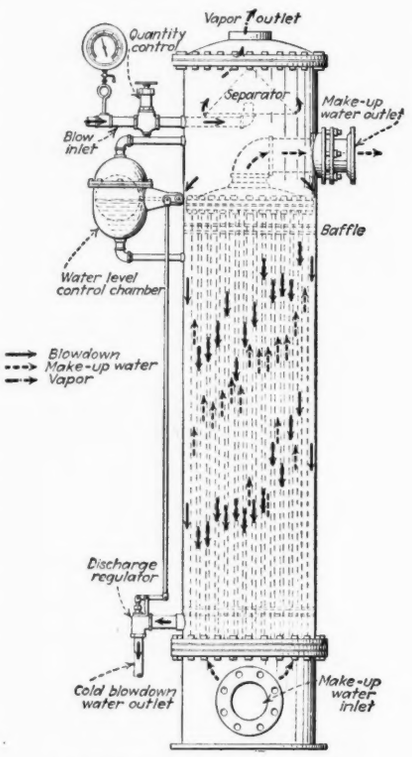


Fig. 1—Flash-type heat reclaimer

definite pressures in the exchangers and establish a differential in pressure between the boiler and the first-stage exchanger in one case and between the two exchangers in the other.

On the discharge from the second

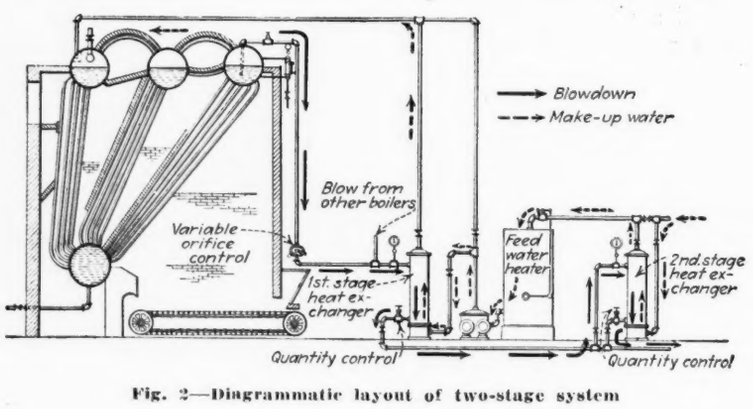


Fig. 2—Diagrammatic layout of two-stage system

exchanger a meter may be installed that will record, integrate, and indicate the flow of blowdown water, and also record the final temperature of the feed water and the discharge temperature of the blowdown water, on one chart.

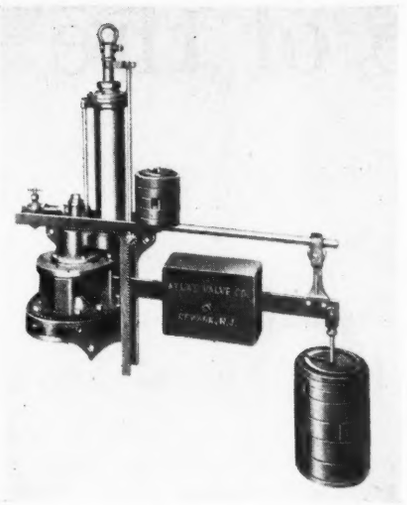
Feed water make-up passes through the exchanger counter to the blowdown, first entering the second-stage exchanger and then passing through the open feed-water heater to the feed pump, by which it is forced through the first exchanger to the boiler.

New Hydraulically Operated Damper Regulator

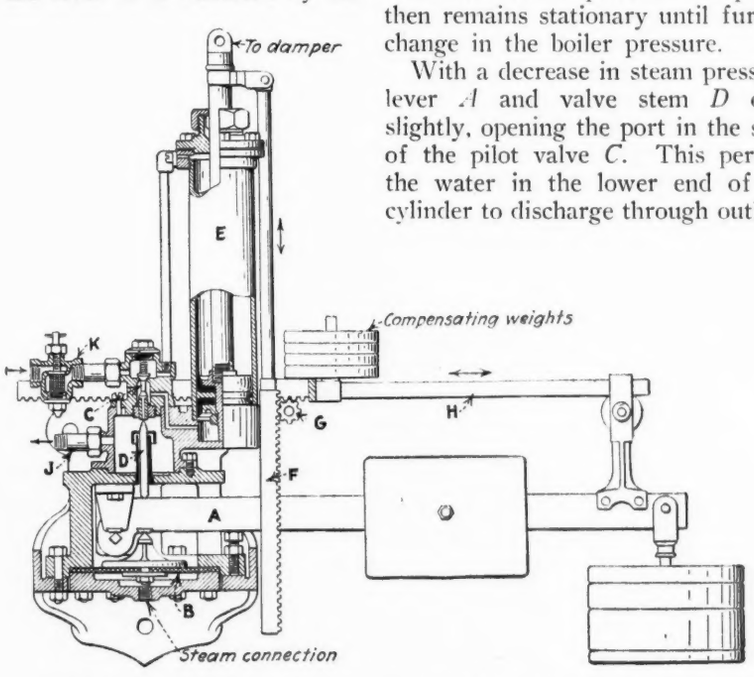
TWO essential characteristics of any damper regulator are, sensitiveness and step-by-step movement of the operating mechanism to assure close regulation of the damper within specified limits. These two characteristics are embodied in an improved regulator, designated No. 503 Victor, recently brought out by the Atlas Valve Company, 282 South St., Newark, N. J.

Referring to the cross-sectional illustration, at normal operating pressure the lever *A* is balanced by the steam pressure below the diaphragm *B* at a point where the discharge port in the stem of the pilot valve *C* is closed by valve stem *D*, and valve *C* is held closed by the spring shown. In this position no water enters or leaves the cylinder *E* and the piston remains stationary. With an increase in the steam pressure the lever *A* will rise and push the pilot valve *C* off its seat. This admits water to the lower end of the cylinder and causes the piston to move upward. As the piston rises, rack *F* is drawn upward and rotates the pinion *G*, which, in turn, causes the weighted arm *H* to move outward to a point where the increase in weight causes the lever *A* to descend and close the pilot valve *C*, shutting off the water pressure to the lower side of the piston. The piston then remains stationary until further change in the boiler pressure.

With a decrease in steam pressure, lever *A* and valve stem *D* drop slightly, opening the port in the stem of the pilot valve *C*. This permits the water in the lower end of the cylinder to discharge through outlet *J* and the pressure on the upper side of the piston to force it downward and thereby decrease the weight on lever *A* to a point where it will again rise and close the discharge port in valve *C* and hold the piston, and likewise the damper, stationary in any intermediate position.



Assembly view of regulator



Regulator is designed to give sensitive operation and to hold damper stationary at any intermediate point between open and closed positions

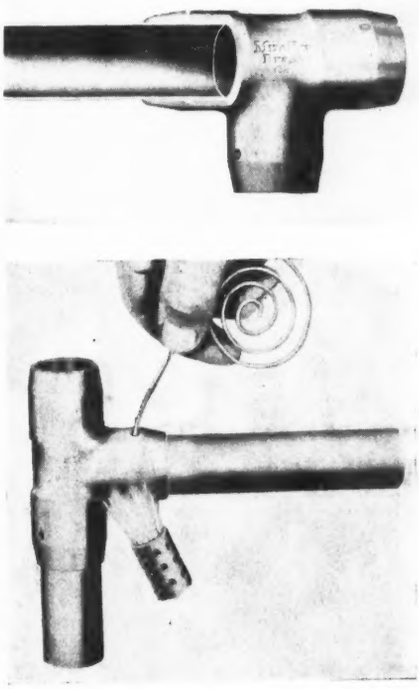
A shut-off valve and strainer are incorporated in the water inlet fitting *K*, the strainer being readily removed for cleaning by unscrewing a cap on the bottom of the fitting.

Streamline Fittings for Piping Systems

A NEW LINE of fittings for use with copper tubing in heating and other industrial applications has been brought out by the Mueller Brass Company, Fort Huron, Mich. All pipe threads and flares are eliminated, the joints being made by means of a blow torch, solder, and the utilization of the law of capillary attraction.

A section of the joint, which consists of a thin film of solder between the tube and fitting, is shown in the upper view in the illustration, and the method of making up the joint is indicated in the lower view. After the tube end has been cleaned and solder paste applied it is inserted in the fitting. The fitting is heated uniformly with a torch, and wire solder is fed through a drilled hole into the solder channel, from which it is distributed by capillary attraction.

In addition to the regular streamline elbows, tees, and couplings, special fittings are available with one outlet threaded so that a job using this material can be tied into an existing threaded pipe installation.



Section of joint in fitting, and method of making up the joint

NEWS of the FIELD

Spot News

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BOULDER DAM *construction will be officially opened on Wednesday, Sept. 17, by a ceremony at the damsite presided over by Ray Lyman Wilbur, Secretary of the Interior, with members of his staff and Western Governors, Senators, and other public officials. Dr. Wilbur will broadcast. Without marking an actual turning point in the job, this event is for the purpose of giving due recognition to a project of such size and importance as a national rather than a local undertaking.*

•

WITH THE SUCCESSFUL SUBMERSION *in Matanzas Bay, Cuba, last week of the great corrugated iron pipe necessary to the attempt of the French scientist, Georges Claude, to extract power from the difference in temperature between the surface and bottom of the tropical ocean, preparations are going forward toward the final steps of the experiment. Professor Claude hopes to be able to announce the success of his project this week, according to press dispatches.*

National Association of Power Engineers Holds Annual Convention at Cleveland

Addresses by prominent engineers and officials, exhibition of power machinery, and entertainment are features of lively meeting; Dobson elected president.

THE NATIONAL CONVENTION of the National Association of Power Engineers at Cleveland, Ohio, opened on Monday, Sept. 8, with the usual registration of delegates and preparation of the machinery exhibits. On Monday night a dance and reception were held in the Public Auditorium.

Tuesday morning was devoted to a number of addresses and responses by the association officials. These were as follows: Invocation by Reverend Walter H. Stark of the Pilgrim Congregational Church; address of welcome by Governor Myers Y. Cooper; response by, National President James A. McDevitt; welcome to Cleveland, by Mayor John Marshall; response, by Vice-President Charles Dobson; address of welcome, by a representative of the Cleveland Chamber of Commerce; response, by Past President Thomas R. Herlihy; presentation of the gavel to National President James A. McDevitt by Chairman Roy E. Bates.

The afternoon and evening were devoted to the various committee meetings. For the visiting women a theater party was given at one of the local theaters.

On Wednesday, after the report of the credentials committee was presented, the official roll call was made, followed by reports from the various committees.

In the afternoon the convention was entertained by a lecture by Arthur B. Oday of the General Electric Company, who gave an interesting talk on the development of lighting devices, from the most primitive oil bowl to the modern Mazda. This was followed by a trip to the Nela Park Laboratory of the National Lamp Works, where the delegates were shown the intricacies involved in the making of a modern lamp bulb.

On Wednesday evening the National Exhibitors Association made up of those firms exhibiting their products at the convention, gave its annual entertainment, made up of a variety of stunts.

The original program embraced two addresses on Thursday, but due to unforeseen events, A. A. Potter, dean of engineering of Purdue University, was unable to be present. However, Dan McQuaid, United States Deputy of the N.A.P.E., delivered a talk on the future of engineering, which did much to dispel the belief of many that power plant engineering was doomed.

Reports of the auditing and resolutions committees, along with the election of officers for the coming year, occupied the convention hours Friday, while Friday night was given over to the installation of the newly elected officers

Gathered outside Public Auditorium for the convention photograph

and to the grand ball. The president for the ensuing year is C. A. Dobson, chief engineer of the Brookside Mills, Knoxville, Tenn.

During the entire five days of the meeting the 1930 Power and Mechanical Exposition was held at the Cleveland Public Auditorium by the National Exhibitors' Association. Supplementing the convention, it contained attractive displays of the latest machinery, devices and accessories for use in the power plant. It was well attended throughout the week.

First 75,000-Kw. Steam Unit at Huntley Station Completed

An addition of 75,000 kw. has just been made to the electrical supply of Buffalo, N. Y., through the putting into service of the first of three new steam turbine-generators at the Charles R. Huntley station of the Buffalo General Electric Company. When the other two machines are put into service the station will have a total capacity of 466,000 kw. and will be the largest in the entire Niagara-Hudson system.

The machine now on the lines, the largest of its particular type yet built, could have supplied the entire electrical needs of Buffalo fourteen years ago. It is fed by two pulverized-fuel boilers each of which is capable of converting 3,320,000 gal. of water into steam in an hour. These boilers are of a type developed by the engineers of the Buffalo, Niagara & Eastern Power Corporation and have unusual features.

The new generator is the seventh unit to be placed in the 25-cycle section of the station. That section now includes 22 boilers with a capacity of 4,560,000 lb. of steam an hour and seven generators with a total capacity of 300,000 kw.

In a new section of the station two additional generators of 80,000 kw. each, one of which will soon be ready for service, are under construction. These will both be 60-cycle machines to supply the downtown loads.

Power Topics to Be Discussed by A.S.M.E. at Three Division Meetings in October

Programs of French Lick meeting, wood industries meeting in New York and petroleum meeting in Tulsa contain papers of interest to power engineers

AN INTERESTING ARRAY of power subjects will be discussed at the three meetings of the American Society of Mechanical Engineers in October. Papers of general interest to power engineers will be presented at the Fall meeting in French Lick Springs, Ind., on Oct. 13-15; the use of wood waste as fuel will be discussed at the Wood Industries Division meeting in New York City, Oct. 16-17, and automatic pipe-line pumping stations will be described at the National Petroleum meeting in Tulsa, Okla., from Oct. 6 to 8.

With headquarters and technical sessions at the French Lick Springs Hotel, the Fall meeting of the A.S.M.E. should prove lively and interesting. Papers to be presented include: "The Diesel Engine for Automobiles," by C. L. Cummins; "A Generation of Progress in Human Engineering," by William A. Hanley; "Interesting Developments in the Conveyor Field," by Henry R. Gotthardt; "Psychometry and Some Common Effects of Air Conditioning on Materials," by D. C. Lindsay.

At the student session embryo engineers from each of the schools listed will read papers on the following topics, among others: "The Power Industry," Armour Institute of Technology; "Cooperative Education," University of Cincinnati; "Research in Mechanical Engineering," University of Illinois; "Heating Research," Kentucky State University; "Mechanical Engineering in the Coal Industry," Rose Polytechnic Institute; "Heat Treatment of Nickel-Steel Weld," Washington University.

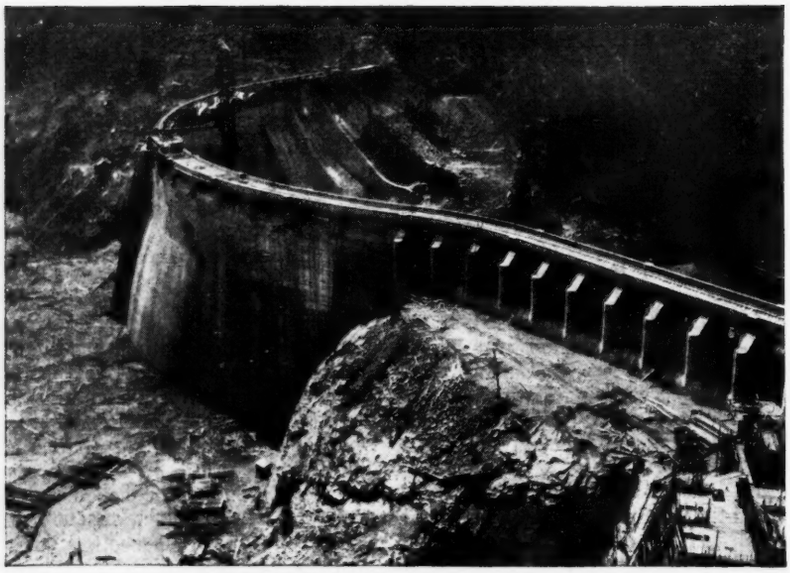
Besides the technical sessions, there will be a program of entertainment features and two of the most brilliant speakers in the country: Edward E. Elliott, president of Purdue University, and Allen D. Albert, assistant to the president of the Chicago World's Fair Centennial Celebration. Excursions have also been arranged to the famous caves of southern Indiana and to the Bedford limestone district, where most of the ornamental building stone comes from. Banquets, golf tournaments and special parties for the ladies round out the full quota of entertainment features.

Following the Fall meeting at French Lick Springs, the fifth National Wood Industries Division meeting will be held at the Hotel Pennsylvania in New York City on Oct. 16-17. A feature of this meeting is the technical session on Thursday morning devoted to a discussion of the use of wood waste as a fuel. Covering the value of wood waste as fuel, the boiler arrangements and the design of fuel feeders for the furnaces, two papers will be presented at the session: "Value of Wood Waste as Fuel," by W. E. Biggs, and "Design of Fuel Feeders for Wood-Burning Furnaces," by M. A. Hofft.

The program of the National Petroleum meeting to be held in Tulsa, Okla., on Oct. 6 to 8, gives promise of both interesting and lively discussion. There will be 24 authoritative technical papers and reports presented at the sessions in the auditorium of the exposition grounds, besides many other unusual features. One feature of particular interest will be a discussion of automatic pipe-line pumping stations, which will be followed by a visit to the automatic pumping station constructed on the exposition grounds by a research committee of the A.S.M.E.

N.A.P.E. members appear to be enjoying their stay in Cleveland

DIABLO DAM DEDICATED



MARKING the completion of three years' work, Diablo Dam, the City of Seattle's great structure across the Skagit River, was turned over to Seattle city officials by L. S. Oakes, president of Winston Brothers Company, which built the dam, at a formal dedication recently. The dedicatory ceremony was held on the 1,180-ft. crest of the dam, which rises 389 ft. above bedrock. More than 300 people, representative of the city's official, business and professional life, participated in the dedication as guests of the City Light Dpartment and Winston Brothers Company, who jointly staged the ceremony.

Preliminary work on the Diablo Dam, which impounds water in the Diablo reservoir extending six miles upstream to the site of the proposed Ruby Dam and containing 90,000 acre-ft. storage capacity, was started Sept. 27, 1927. Completion of the dam is a great step forward in the progress of the City of Seattle's hydro-electric development project. The initial installation in the Diablo power plant will provide for 167,000 hp.; the ultimate capacity will be 225,000 hp. The ultimate cost of the Diablo development, including the present dam, proposed power house and transmission lines, is estimated at $11,000,000.

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A.S.T.M. Revises Standards for Steels and Boiler Tubes

Announcement is made by the American Society for Testing Materials of the formal adoption of a number of revisions in the standard specifications for various steel products. Among these are the specifications for commercial-quality hot-holled bar steels and cold-finished bar steels and shaftings applicable to the screw-steel grades increasing the sulphur content to provide better machineability.

The specifications for structural steel for forge welding have been revised to allow higher silicon content by agreement between purchaser and manufacturer.

The selection of test specimens in specifications for lap-welded and seamless steel and lap-welded iron boiler tubes, and the tolerances for this material have been modified; and specifications for alloy steel bolting material for high-temperature service have been limited to cover bolting stock up to and including 2½-in. diameter.

A number of tentative standards and tentative revisions to standards have been adopted as standard, there having been no criticism during the past year of the tentative specifications.

General Motors Purchases Winton Engine Company

General Motors Corporation of Detroit, Mich., has entered the Diesel engine industry with the acquisition of the Winton Engine Company of Cleveland, Ohio, a leading builder of marine and industrial Diesel engines. The purchased company will be known from now on as the Winton Engine Corporation, and officers and personnel of the old company will remain with the new corporation to carry forward the development and production of its products.

Located in the western section of Cleveland, on approximately four acres of land, the present Winton plant consists of two machine shops, 80 x 300 ft. and 50 x 310 ft.; an assembly department, 100 x 360 ft.; a heat-treating department, 18 x 50 ft.; pattern shop, 30 x 172 ft.; boiler house, 30 x 40 ft.; and a modern experimental shop, 35 x 153 ft. A three-story office building was just completed last year, bringing the total floor space in the plant to approximately 90,000 square feet.

Leaders in the Diesel field regard General Motors' entry as the most important event in the industry for years.

Inland Power to Install Largest Overhung Unit

For the Inland Power & Light Company's coming water-power development at Ariel, on the Lewis River, Wash., the General Electric Company is building at Schenectady what it asserts to be the largest overhung-type hydro-electric generator ever made, the generators installed at Niagara Falls and those being built for the Dnieper River in Russia not belonging to that type.

The generator for the Ariel plant is a 60-pole, 56,250-kva., 120-r.p.m., three-phase, 60-cycle, 13,800-volt machine, with an over-all diameter of more than 37 ft. and of semi-outdoor construction. The S. Morgan Smith Company will supply the water turbine, which will develop 61,600 hp. at a 185-ft. head and 67,000 hp. at a 189-ft. head.

Simultaneously at the same works the four smallest overhung hydro-electric generators yet made, rated at 3,300 kva. each, are being manufactured for the Grafton Power Company for installation this fall on the Connecticut River at McIndoes Falls, Vt.

Trade Commission to Resume Utility Hearings, Sept. 29

Federal Trade Commission hearings in the public utilities investigation will be resumed, regardless of the late fire, on Monday, Sept. 29, at the Interior Department Building, Washington, D. C. Two companies of the Electric Bond & Share group will be subject to examination: the Carolina Power Company, a National Power & Light subsidiary; and the Minnesota Power & Light Company, among the American Power & Light properties. Hearings will be in the financial phase of the investigation.

Reorganization of the disrupted work is shaping up nicely after the fire which destroyed the Trade Commission building on Aug. 30. As tentatively reported last week, few papers pertaining to the utilities investigation were destroyed. The docket section and the wings housing the legal and economic staff engaged in the power probe came out virtually undamaged. Some papers exposed on desks were burned but can be duplicated. Most of the personnel working on public utilities have been moved to quarters in another old temporary building across the street, their files with them, and are functioning as usual.

Add 22 Boiler Inspectors to Steamboat Service

To provide more frequent inspection of steam vessels on all United States waters 22 additional assistant inspectors of boilers and 23 assistant inspectors of hulls have been added to the force of the Commerce Department's steamboat inspection service, according to announcement last week by Dickerson N. Hoover, supervising inspector general.

Addition of these men, Mr. Hoover stated, will permit three reinspections of a class of vessels which formerly, because of limited personnel, received only one annual inspection. More frequent inspections will cover all American and foreign passenger vessels, the latter whether under reciprocity or not, during the season of navigation of the year for which certificated, in addition to the annual inspection each year. Inspectors will see that a thorough examination of each ship is made, particularly to see that all equipment is in good condition and ready for immediate use.

Of the 22 assistant boiler inspectors added, those already appointed in the various districts are: San Francisco, Charles W. Miller, Jr.; Los Angeles, Byron A. Minor; New York, Myer Stockman and Oscar Olsen; Baltimore, Daniel A. Heyn; Boston, Frank J. Hicken and Everett M. Ward; Cleveland, John W. Lozier; Buffalo, Frank E. McLean; New Orleans, James D. Cuthell and Charles M. Vasterling; Galveston, William E. Coates; Mobile, John Sherlock.

McGraw-Hill Book Company Enters General Field

The McGraw-Hill Book Company, which for more than twenty years has been internationally known as a leading publisher of books on engineering, science and business, will enter the general publishing field this month with a list of new books addressed to the lay reader and intended for sale through the book stores of the country.

To differentiate between its new activities and the more technical publications to which it has confined itself in the past, the trade publishing department of the company will hereafter be known as Whittlesey House, and its publications will bear that imprint on their title pages.

The first list of Whittlesey House publications embraces a wide variety of subjects, and includes among its list of authors many distinguished names,—men of such repute as Harlow Shapley, professor of astronomy of Harvard University; Harlan T. Stetson, director of the Perkins Observatory; Bailey Willis, research associate of the Carnegie Institute of Washington, and one of the world's leading authorities on earthquakes; Ales Hrdlicka, curator of the division of anthropology of the Smithsonian Institution; William Franklin Sands, Ernest Minor Patterson, and others, who have contributed books in such diverse categories as astronomy, history, economics, psychology, anthropology, travel and the like.

New Unit for Government Plant at Shoshone

Additional service is being extended to communities in the vicinity of Powell, Garland and Lovell, Wyo., by the Mountain States Power Company, which recently has contracted to take additional power from the United States Reclamation Service from its plant at Shoshone dam.

The new contract calls for the immediate installation in the 2,000-hp. power plant of an additional 5,500-hp. turbine-generator. The Reclamation bureau already has completed part of the increased equipment necessary by installing a large switching station at Cody and building a duplicate transmission line from the power plant at the dam down to Cody.

By the terms of the new arrangement, the power company assumes the operation and maintenance of all main transmission lines, substations, and other electrical equipment eastward from Cody and through which the company has previously received electrical energy.

News of Canada

Additions to Ruskin network progressing rapidly — Six units in operation at Back River — Beauharnois orders seven large transformers

ADDITIONS to the power network serving the lower mainland of British Columbia are making their appearance now that the first unit of the British Columbia Electric Railway Company's new hydro-electric plant at Ruskin is nearing completion. Two high-tension lines will take the Ruskin power to Burnaby substation, and the work on these is progressing rapidly. The upper river crossings over the Fraser River have their steel towers completed, and there only remains the stringing of the conductors. Coincident with this line work, officials of the company report the construction of a 60,000-volt transmission tie-line between Ruskin and the existing plant at Stave Falls, a distance of about three and a half miles.

THE Montreal Island Power Company, controlled jointly by Montreal Light, Heat & Power Consolidated and Power Corporation of Canada, reports six units in operation at the new plant on the Back River, capable of developing a minimum of 42,000 hp. and the maxi-

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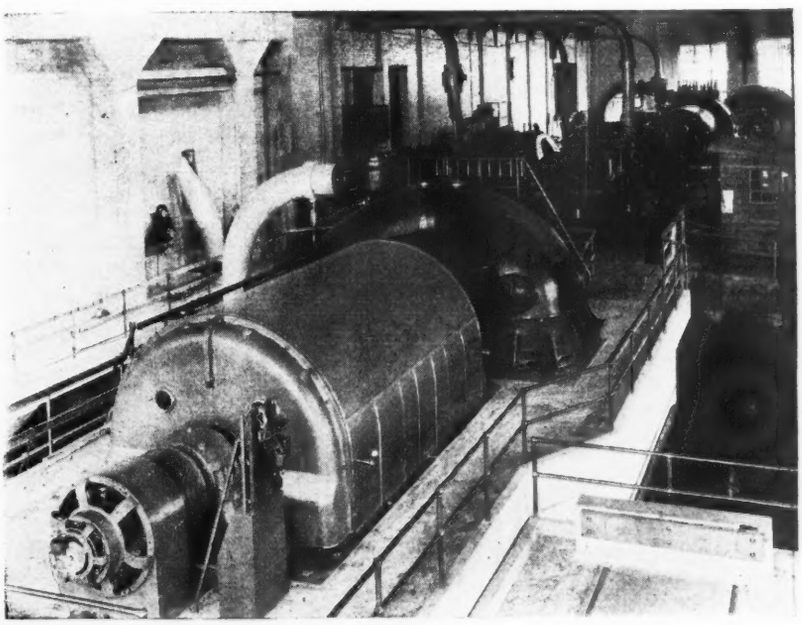
NEW UNIT FOR PORTLAND, ORE.



INCREASED steam-generating capacity on the system of the Pacific Northwest Public Service Company, Portland, went into service recently with the completion of the installation of a 35,000-kw., 11-kv., 60-cycle, 1,800-r.p.m., General Electric Company turbine-generator. The unit is installed in a new addition to the Station L plant of the company, where a 26,500-sq.ft. Stirling boiler was recently installed.

This brings the total installed generator capacity of the station up to 77,500 kw. in six units. Some of the smaller and older units are little used, however, and the station's capacity based upon its boiler capacity is rated at 63,000 kilowatts.

mum of 70,000 hp. According to the original plans of this development, it is the intention to install ten units with a maximum development of 120,000 hp. and a minimum development of 70,000 hp. The wide spread in rated capacity is due to unusual water conditions on the river which make it necessary to provide for the large installation in order that a minimum of 70,000 hp. may be secured.

THE ORDER for seven high-tension transformers for the Beauharnois Power Corporation's power house on the St. Lawrence River has been obtained by the Canadian Westinghouse Company. The equipment is to be used to step up the voltage for transmission to the Montreal Power Company and the Ontario Hydro-Electric Power Commission. The capacity of the units totals 250,000 hp. Before the plant is brought up to its 500,000-hp. capacity the corporation will place orders for about eight similar transformers.

Portland, Ore., to Study Plan for Municipal Power System

For the purpose of gathering data and investigating the possibilities of establishing a municipal power system in the city of Portland, Ore., the city council has agreed to place in the 1931 budget an item of $25,000. Mayor George L. Baker has requested in this connection the services of O. Laurgaard, city engineer; Frank S. Grant, city attorney; Ben S. Morrow, engineer of the water bureau; and John J. Curtin, city statistician, to gather such data for the council.

At the time this action was taken, it was recalled that a similar amount for the identical purpose was placed in the budget last year by Commissioner Stanhope S. Pier, but that the item had been disallowed by the tax conservation commission.

Brooklyn Poly Offers Many Graduate Courses

Many courses of interest and value to graduate engineers are being offered this fall on the day and evening curricula of the Polytechnic Institute of Brooklyn, N. Y. Included among those related particularly to the field of power are evening courses in water-power engineering, power distribution theory, contemporary advances in electrical engineering, heat power engineering, combustion engineering, oil and gas power engineering and engineering economics.

The combustion engineering course, according to the institute's department of mechanical engineering, is intended for those technically interested in combustion under the conditions existing in the boilers of modern power plants. It will consist mainly of lectures given by John Blizard, head of the research department of the Foster-Wheeler Corporation, with opportunity for discussion and solution of illustrative problems.

Most of the evening courses will begin during the week of Sept. 29 and continue through May. A few will start later in the year. Full information may be obtained from Dean Erich Hausmann, Polytechnic Institute of Brooklyn, Court and Livingston Sts., Brooklyn, N. Y.

Coming Conventions

American Society of Mechanical Engineers. Fall meeting at French Lick Springs, Ind., Oct. 13-17. National Wood Industries Division. Meeting at the Hotel Pennsylvania, New York City, Oct. 16-17. National Petroleum Meeting at Tulsa, Okla., Oct. 6-8. Annual meeting in New York City, Dec. 1-5. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Engineering Council. Administrative board meeting at the Mayflower Hotel, Washington, D. C., Oct. 17-18. Secretary, L. W. Wallace, 26 Jackson Pl., Washington, D. C.

American Institute of Electrical Engineers. District meeting at Philadelphia, Pa., Oct. 13-15. District meeting at Louisville, Ky., Nov. 19-22. Annual Winter convention in New York City, Jan. 26-30, 1931. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Society of Refrigerating Engineers. Annual meeting at the Hotel New Yorker, New York City, Dec. 3-6. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Welding Society. Fall meeting at the Congress Hotel, Chicago, Ill., Sept. 22-26. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Midwest Power Engineering Conference and Exhibition. Fifth meeting in Chicago, Ill., Feb. 10-13, 1931. Secretary, George E. Pfisterer, 308 West Washington St., Chicago, Ill.

National Association of Practical Refrigerating Engineers. Annual convention and exhibition at the Hotel Peabody, Memphis, Tenn., Nov. 11-14. Secretary, Edward H. Fox, 5707 West Lake St., Chicago, Ill.

National Association of Purchasing Agents. District convention at the William Penn Hotel, Pittsburgh, Pa., Oct. 16-17. Secretary, A. D. Feeman, Superior Steel Corporation, Carnegie, Pa.

National Power Show. Grand Central Palace, New York City, Dec. 1-6. Manager, Charles F. Roth, Grand Central Palace, New York City.

New England Water Works Association. Annual convention at Haddon Hall, Atlantic City, N. J., Sept. 23-26. Secretary, Frank J. Gifford, 715 Tremont Temple, Boston, Mass.

Society of Industrial Engineers. Seventeenth national convention at the Mayflower Hotel, Washington, D. C., Oct. 15-17. Secretary, George C. Dent, 205 West Wacker Drive, Chicago, Ill.

Personals

GEORGE L. KNIGHT, mechanical engineer of the Brooklyn Edison Company, was tendered a dinner in Brooklyn, N. Y., on Sept. 10, by more than 150 employees of the mechanical engineer's department of the company. The dinner was in celebration of Mr. Knight's completion of 25 years service with the company. He was presented with an engraved gold watch. An engineer of wide experience, Mr. Knight was responsible for the design and construction of Hudson Avenue station.

G. JOHN GRUBB, until recently designing engineer in the centrifugal pump department of Babcock-Wilcox & Goldie-McCulloch, Ltd., of Galt, Ont., has joined the Yeomans Brothers Company of Chicago in a similar capacity.

GEORGE E. SEABURY, superintendent of the station engineering department of the Edison Electric Illuminating Company of Boston, Mass., is chairman of the Engineering Societies of Boston.

RAY P. TARBELL, formerly with the Lincoln Electric Company, Cleveland, Ohio, has recently become a member of the firm of Robert E. Kinkead, Inc., consulting welding engineers of Cleveland. As vice-president and secretary, Mr. Tarbell will assist Mr. Kinkead in the specialized welding work of the firm.

HOWARD A. STANLEY, vice-president and assistant general manager of the Fall River Electric Light Company, has been transferred to the engineering department of the New England Power Association at Providence, R. I. EDWARD CABOT, formerly manager of the Quincy Electric Light & Power Company, has been appointed to succeed Mr. Stanley at Fall River, and NEWELL A. CLARK, assistant general manager of the Narragansett Electric Company, has been made manager of the Quincy company to succeed Mr. Cabot.

CLAUDE O. STREETER has joined the Schwartz Belting Company of New York City in the capacity of chief mechanical engineer. For the past eighteen years Mr. Streeter has been chief mechanical engineer of the Graton & Knight Company and its subsidiaries. He is widely known throughout the field of mechanical power transmission and has been active in transmission research.

CHARLES B. BURLEIGH, for many years manager of the central-station department of the General Electric Company's New England district, retired from active service on Sept. 1. Entering the employ of the old Thomson-Houston Electric Company in 1884 as erecting engineer, Mr. Burleigh's career has been intimately associated with the development of the power industry in the New England states.

Business Notes

MULTI-VALVE CORPORATION, New London, Conn., has appointed the following new sales representatives: O'Brien Steam Specialty Company, Syracuse, N. Y.; Refrigerating & Power Specialties Company, San Francisco and Los Angeles, Calif.; Walter J. Ottinger, 1683 Beechwood Ave., Cleveland, Ohio; Edward F. Wilson, 1409 Keystone Bldg., Pittsburgh, Pa.; Kindred Appliances Company, 53 Park Place, New York City, and Drexel Building, Philadelphia, Pa.

L. J. WING MANUFACTURING COMPANY, New York City, announces the appointment of the Harry G. Murphy Sales Company, 316 Union National Bank Bldg., Scranton, Pa., as sales representative for northeastern Pennsylvania.

FOOTE BROS. GEAR & MACHINE COMPANY, Chicago, Ill., has recently appointed the J. L. Hart Machinery Company, South Florida and Eunice Aves., Tampa, Fla., representative in southern Florida.

YEOMANS BROTHERS COMPANY, Chicago, Ill., has just appointed C. Calor Mota to handle the exclusive representation of its product in Porto Rico. Mr. Calor's offices are located in Mayaguez.

DELTA-STAR ELECTRIC COMPANY, Chicago, Ill., announces that its line of solderless clamp-type wire connectors, listed in Bulletins 38-CB, 38-CC and 38-CD, have been approved and will be listed by the Underwriters' Laboratories.

ST. JOHN X-RAY SERVICE CORPORATION, New York City, announces the removal of its laboratory to the Eveready Building, 30-20 Thomson Ave., Long Island City, N. Y. In its new quarters, the company states, it is prepared to handle anything weighing up to five tons, which can be X-ray inspected.

ELLIOTT COMPANY, Jeannette, Pa., announces the following changes in the addresses of its sales representatives: F. G. Moritz, resident sales engineer under the Kansas City office, is now located at 50 Tulsa Trust Bldg., Tulsa, Okla.; L. T. Stevens, resident sales engineer working under the Atlanta office, is now located at 1107 American Bank Bldg., New Orleans, La.

CLIMAX ENGINEERING COMPANY, Chicago, Ill., announces that Forest Dunlap, with headquarters at Tulsa, Okla., has been placed in charge of Kansas, Oklahoma and Arkansas sales. L. L. Machia, in charge of oil field sales of the company, has changed his headquarters from Clinton, Iowa, to Fort Worth, Texas. F. E. Blanchard, in charge of dealers and service parts organizations and the power unit division of the company, has taken up headquarters at the company's main office in Chicago.

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How's Business?

THE MARKED LULL in business activity this year at the end of August and the beginning of September has been followed by a general freshening of business sentiment as signs of seasonal improvement accumulate. Lengthened plant holidays and deferred check payments in the fortnight including Labor Day dropped our index to 83.5% of normal despite evidence that business recovery, beginning as usual with the basic industries and primary distribution, is proceeding normally in response to seasonal stimulus. Coal and electric power production are increasing, steel output is being maintained, car loadings are rising. Expansion of commercial loans and currency circulation indicate a rising volume of wholesale nad retail trade as the fall buying movement gets under way. Business is beginning to feel better than it looks. —*The Business Week*, Sept. 17.

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Trade Catalogs

COMPRESSORS—Bulletin P-14, centrifugal blowers; P-5, compressors; Elliott Company, Suite 506 Morris Bldg., Pittsburgh, Pa.

INSTRUMENTS—Catalog No. 6, instruments for pulp and paper industry; No. 1400, engraved thermometers; No. 4000, pyrometers; Taylor Instrument Companies, Rochester, N. Y.

INSULATION — Manual No. 102, "Service to the Power Plants," Johns-Manville Corporation, 292 Madison Ave., New York City.

COMPRESSORS AND PUMPS—Bulletin No. 150, after coolers, and No. 215 centrifugal pumps, Pennsylvania Pump & Compressor Company, Easton, Pa.

PUMPS—Bulletin No. 201, centrifugal pump selection charts, Goulds Pumps, Inc., Seneca Falls, N. Y.

INSTRUMENTS — Catalog No. 80, resistance thermometers; No. 90, "The Hump Method for Heat Treatment of Steel;" Bulletin 880, direct reading humidity recorder; Leeds & Northrop Company, 4901 Stenton Ave., Philadelphia, P.

WELDING—"Automatic Arc Welding by the Electronic Tornado Process," Lincoln Electric Company, Coit Rd., and Kirby Ave., Cleveland, O.

WELDING—Bulletin No. 6, unbeveled plate welding, Fusion Welding Corporation, 10257 Torrence Ave., Chicago, Ill.

INDUSTRIAL PAINTS—Booklet, "Master Specifications," Joseph Dixon Crucible Company, Jersey City, N. J.

BOILERS—Type C 3-drum boiler booklet, Erie City Iron Works, Erie, Pa.

MOTORS AND GENERATORS — Bulletin No. 101, induction motors; No. 401, motor-generator sets; No. 901, arc welders; Burke Electric Company, Erie, Pa.

HEAT EXCHANGERS—Bulletin No. 100, heat exchangers, Whitlock Coil Pipe Company, Hartford, Conn.

ECONOMIZERS—Catalog EC-1, C-E economizer, Combustion Engineering Corporation, 200 Madison Ave., New York City.

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Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Navy Standard	New York	$2.10 @ $2.30
Kanawha	Cincinnati	1.10 @ 1.35
Smokeless	Cincinnati	1.75 @ 2.00
Smokeless	Chicago	2.00 @ 2.25
West Kentucky	Louisville	.85 @ 1.25
Steam	Pittsburgh	1.50 @ 1.60
Gas Slack	Pittsburgh	.90 @ 1.10
Big Seam	Birmingham	1.60 @ 1.75

Anthracite (Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.00
Barley	New York	1.15 @ 1.50

FUEL OIL

New York—Sept. 11, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75c.@5.25c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c.@6.25c. per gal.

St. Louis—Sept. 4, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.345 per bbl., or 42 gal.; 26@28 deg., $1.420 per bbl.; 28@30 deg., $1.520 per bbl.; 30@32 deg. $1.620 per bbl.; 32@36 deg., gas oil, 3.776c. per gal.; 38@40 deg., distillate, 4.401c. per gal.

Pittsburgh — Sept. 3, f.o.b. local refinery, 34@36 deg., fuel oil, 3.5c. per gal.; 36@40 deg., 3.5c.

Philadelphia—Sept. 9, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.475@$1.525 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

Cincinnati — Sept. 9, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Sept. 6, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 60c. per bbl.; 26@30 deg., 75c. per bbl.; 30@32 deg., 87.5c. per bbl.

Boston—Sept. 8, tank-car lots, f.o.b., 12@14 deg., Baumé, 3.3c. per gal.; 28@32 deg., 5c. per gal.

Dallas—Sept. 6, f.o.b. local refinery 26@30 deg., $1.10 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ark., Benton—State of Arkansas, is having plans prepared for the construction of a group of buildings, including dormitories, kitchen, store, central power and heating plants, etc., near here. Estimated cost $3,000,000. Mann, Wanger & King, Donaghey Bldg., Little Rock, are architects.

Ark., West Memphis—City has work under way on a waterworks system including 50,000 gal. reservoir, 100,000 gal. tank on tower, 40 x 50 ft. power plant. Estimated cost $38,000. Voiz Construction Co., Baltimore Bldg., Memphis, Tenn., are contractors.

Calif., Linden — Linden Irrigation Dist., is having plans prepared for the construction of a low diversion dam and small pumpings on Calaveras River. Estimated cost $100,000. F. H. Tibbetts, Alaska Commission Bldg., San Francisco, is engineer.

Idaho, Soda Springs — City voted $30,000 bonds for the construction of a municipal hydro-electric plant.

Ill., Wilmette—City plans an election Nov. 4 to vote $600,000 for pumping and filtration plant. Pearse, Greeley & Hansen are consulting engineers.

Ind., Goshen—City received lowest bid for the construction of a Diesel powered electric light plant to include three Diesel engines from Fulton Iron Works, 1259 Delaware St., St. Louis, Mo. Estimated cost $200,000.

Kan., Holton—City, J. A. Pomeroy, Clk., will soon award contract for additions and alterations to present power plant, including cement foundation for new oil engine. $15,000. Black & Veatch, Mutual Bldg., Kansas City, Mo., are engineers.

La., Kenner—Water Board, will receive bids until Oct. 15 for waterworks improvements including filter plant, pumping plant, etc. H. A. Mentz, Hammond, is engineer.

Mass., Fall River—Berkshire Fine Skinners, c/o Chase Electric Co., 150 Poscasset St., Contr., awarded contract for the construction of a switch house, transformer cage, etc., on South Quarry St. Estimated cost $40,000.

Mass., Waltham—City will soon receive bids for waterworks improvements including pump house, etc. Estimated cost $50,000. Private plans.

N. J., Asbury Park — Memorial Hospital, awarded contract for a 5 story hospital, nurses home, boiler house, and laundry building on Corlies Ave., to Walter Kidde & Co., 140 Cedar St., New York. Estimated cost $1,100,000.

N. J., Jersey City — Mongiello Bros., 625 Communipaw Ave., will not construct 1 story, 100 x 100 ft. ice plant. $40,000. Project in abeyance.

N. J., Montclair—Public Service Production Co., 80 Park Pl., Newark, plans the construction of a group of buildings, including garage, shop, boiler house, offices and service rooms at 101 Greenwood Ave., here. Estimated cost $150,000.

N. J., Sewaren — Shell Eastern Petroleum Production Co., 122 East 42nd St., New York, N. Y., awarded contract for the construction of a boiler house, power unit, compounding and tank rooms to Cross & Roberts, Inc., Statler Bldg., Boston, Mass. $150,000.

N. J., Skillman — Dept. of Institutions & Agencies, State Office Bldg., Trenton, received lowest bid for the construction of a 2 story, 70 x 90 ft. power house at State Village for Epileptics here, from General Contracting & Construction Co., 133 East Front St., Trenton. Estimated cost $100,000. Former bid rejected.

N. J., Trenton—City Commission, will receive bids until Sept. 19 for addition to Trenton pumping station. Estimated cost $50,000. J. O. Hunt, 219 East Hanover St., is engineer.

N. Y., Brooklyn—Brooklyn Hospital Inc., A. Van Sinderen, Pres., plans the construction of a 3 story refrigeration plant at De Kalb Ave. and Ashland Pl. Estimated cost $40,000. Lord & Hewlett, 2 West 45th St., New York, are engineers.

N. Y., Brooklyn — Paramount Ice Co., 241 Ellery St., plans the construction of a 100 x 150 ft. ice plant, at Steuben St. and Myrtle Ave. Estimated cost $60,000. G. J. Lobenstein, 885 Flatbush Ave., is engineer.

N. Y., Flushing—Queensboro Hill Community Church, R. Anderson, 5812 134th St., is having sketches made for a 1 story, 38 x 55 ft. boiler room and coal storage building at 138th St. and 60th Ave. Estimated cost $45,000. W. B. Willis, 171 Madison Ave., New York, is associate architect.

N. Y., New York—New York Central R.R., 466 Lexington Ave., had plans prepared for the construction of a 60 x 92 ft. substation at West 66th St. and West End Ave. Estimated cost $110,000. F. B. Freeman is chief engineer.

O., Cincinnati—Dept. of Welfare, Ninth and Oak Sts., will receive bids until Sept. 23 for the construction of a power house at Longview State Hospital. Estimated cost $65,000. T. R. Ridley, Ohio-Hartman Bldg., is engineer.

O., Columbus—Bd. of Purchases, H. C. Cain, Secy., will receive bids until Sept. 23 for sluice gates and appurtenances including electrical operating equipment in connection with sewage treatment work. Estimated cost $50,000. R. H. Simpson, City Hall, is engineer.

Okla., Hominy — City is having preliminary plans prepared for the construction of a municipal electric light plant. Estimated cost $50,000. Engineer not announced.

Okla., Vinita—City is having plans prepared for the construction of a municipal light plant. Estimated cost $200,000. Russell & Axon, McDaniel Bldg., Springfield, Mo., are engineers.

Tenn., Collierville — City plans an election Sept. 30 to vote $30,000 for waterworks improvements, including pumping plant, etc.

Tenn., Lebanon—City voted $200,000 bonds for extensions and improvements to waterworks, including pumping and filtration plant to bring water from Cumberland river six miles away. Wiberman & Singleton, Atlanta, Ga., are engineers.

Tex., Pettus — Humble Oil Pipe Line Co., Humble Bldg., Houston, will build a pumping station near here in connection with proposed electrically driven pipe line from Refugio to Pettus. Estimated cost $30,000. Work will be done by owner's forces.

B. C., Vancouver—British Columbia Electric Railway Co., has made application to provincial water board for permit to divert 400 second ft. of water for a hydro electric project on the Sproat River to supply the growing communities on West Coast of Vancouver Island. Initial capacity will be 1,000 hp. to be used largely for the industries of Alberni and Port Alberni districts, and to be increased as consumption demands.

B. C., Trail—West Kootenay Power & Light Co. Ltd., L. A. Campbell, Gen. Mgr., had made application to Provincial Government for permit to construct a hydro-electric power development on the Kootenay River to develop 30,000 hp.

Equipment Wanted

Boilers—Pasadena, Calif.—City will soon readvertise for bids for boiler for municipal power plant. Former bids rejected.

Electric Control—Boston, Mass.—Dept. of Public Works, City Hall, plans to purchase equipment and electric control for Summer St. draw bridge.

Engines and Boilers, etc.—Longview, Tex.—J. K. Bivins Lumber Co., Moberly and Young Sts., will soon receive bids for engines and boilers (portable), etc.

Pump—Long Beach, Miss.—City, J. A. McCormick, Clk., will receive bids until Oct. 7 for a 350 g.p.m. centrifugal pump direct connected to electric motor complete with necessary fittings.

Pumps — Gulfport, Miss. — U. S. Veterans Bureau, 764 Arlington Bldg., Washington, D. C., will receive bids until Sept. 30 for pumps, etc., for proposed sewage disposal plant.

Pumps—Orient, O.—Dept. of Welfare, H. H. Griswold, Dir., Columbus, will receive bids until Sept. 22 for chemical pump and wash water pump for proposed waterworks at Institution for Feeble Minded here. Estimated cost $23,000.

Pumps, Motors, Etc. — Milwaukee, Wis. — Sewerage Commission, will receive bids until Sept. 26 for three 15 m.g.p.d. centrifugal pumps and accessories for electric return sludge pumping plant.

Transformers—Los Angeles, Calif.—City, c/o T Oughton, Purch. Agt., will receive bids until Sept. 23 for six 20 kw., two 25 kw. and ten 30 kw. subway type transformers.

Transformers, Switchboard, etc. — West Boylston, Mass. — Metropolitan District Water Supply Commission, 24 School St., will receive bids until Sept. 23 for furnishing and installing transformers, switchboards and other electrical equipment in connection with construction of outlet works at Shaft 1 of Wachusett-Coldbrook tunnel.

Industrial Projects

Calif., Riverside—Casa Blanca Packing House, awarded contract for a 2 story, 70 x 90 ft. pre-cooling plant to Gay Engineering Corp., 2650 Santa Fe Ave., Los Angeles.

D. C., Washington—O. J. Maigne Co., 332 C St. N. W., will receive bids about January 1 for the construction of a 3 story factory for the manufacture of printers rolls. Dodge & Morrison, 160 Pearl St., are architects.

Ind., South Bend—Bendix Aviation Co., had plans prepared for the construction of plant "B." Estimated cost $125,000. Private plans.

Mass., Cambridge (Boston P. O.) — A. H. Hews & Co., Inc., 205 Richdale Ave., awarded contract for the construction of a pottery plant, to Stone & Webster, Inc., 49 Federal St., Boston. Estimated cost $50,000.

Mass., Dighton—Anchor Color & Gum Works, are receiving bids for a power plant. Estimated cost to exceed $40,000. E. I. Marvell, 290 Bedford St., Fall River, is engineer.

Mass., Hyde Park (Boston P. O.)—Condit Electric Mfg. Co., 344 Hyde Park Ave., is having preliminary plans prepared for addition and alterations to factory. Estimated cost $50,000. Private plans.

Mass., Leominster—DuPont Viscoloid Co., R. W. Brokaw, Arlington, N. J., awarded contract for a 3 story, 75 x 125 ft. glass plant unit, building 100 on Lancaster St., to Wiley & Foss, Central St., Fitchburg. Estimated cost to exceed $40,000.

Mass., Malden—Malden Electric Co., J. T. Day, Mgr., 157 Pleasant St., plans the construction of a distribution station, warehouse and laboratory on Centre St. Estimated cost $50,000. Private plans.

N. Y., Syracuse—Pierce, Butler & Pierce, 41 East 42nd St., New York, will receive bids about Dec. 1 for the construction of a boiler manufacturing plant here. Estimated cost to exceed $40,000. Private plans.

Pa., Clairton—Carnegie Steel Co., Carnegie Bldg., Pittsburgh, awarded contract for the construction of a coal washing plant to Koppers Rheolaveur Co., Koppers Bldg., Pittsburgh. Coal brought by barge to Clairton, unloaded by belt conveyors to three 1,000 ton storage bins, thence by belt conveyors to washing plant proper. After washing and drying, will be conveyed by belt to oven bins, thence to coke ovens. Estimated cost $2,000,000.

Wis., Milwaukee—A. O. Smith Corp., 27th and Keefe Sts., manufacturers of pressed steel and welded products, awarded contract for a 1 story, 225 x 245 ft. factory on 27th St. to Worden-Allen Co., Port Washington. Estimated cost $200,000.

Ont., Copper Cliff—International Nickel Co., awarded contract for remodeling and reconstructing old smelter to Fraser-Brace Engineering Co. Ltd., 107 Craig St. W., Montreal, Que. Estimated cost $2,000,000.

Ont., Toronto—Canadian Pacific Ry., H. O. Windsor Station, Montreal, Que., awarded contract for the construction of a group of buildings, including charcoal, storehouse, yard office, charging plant, dope retaining building, shelter, repair shop, linen storage, truck platforms and two standpipes, bunk house, addition to round house, etc., to Anglin-Norcross Ltd., Temple Bldg., Toronto. Estimated cost $500,000.